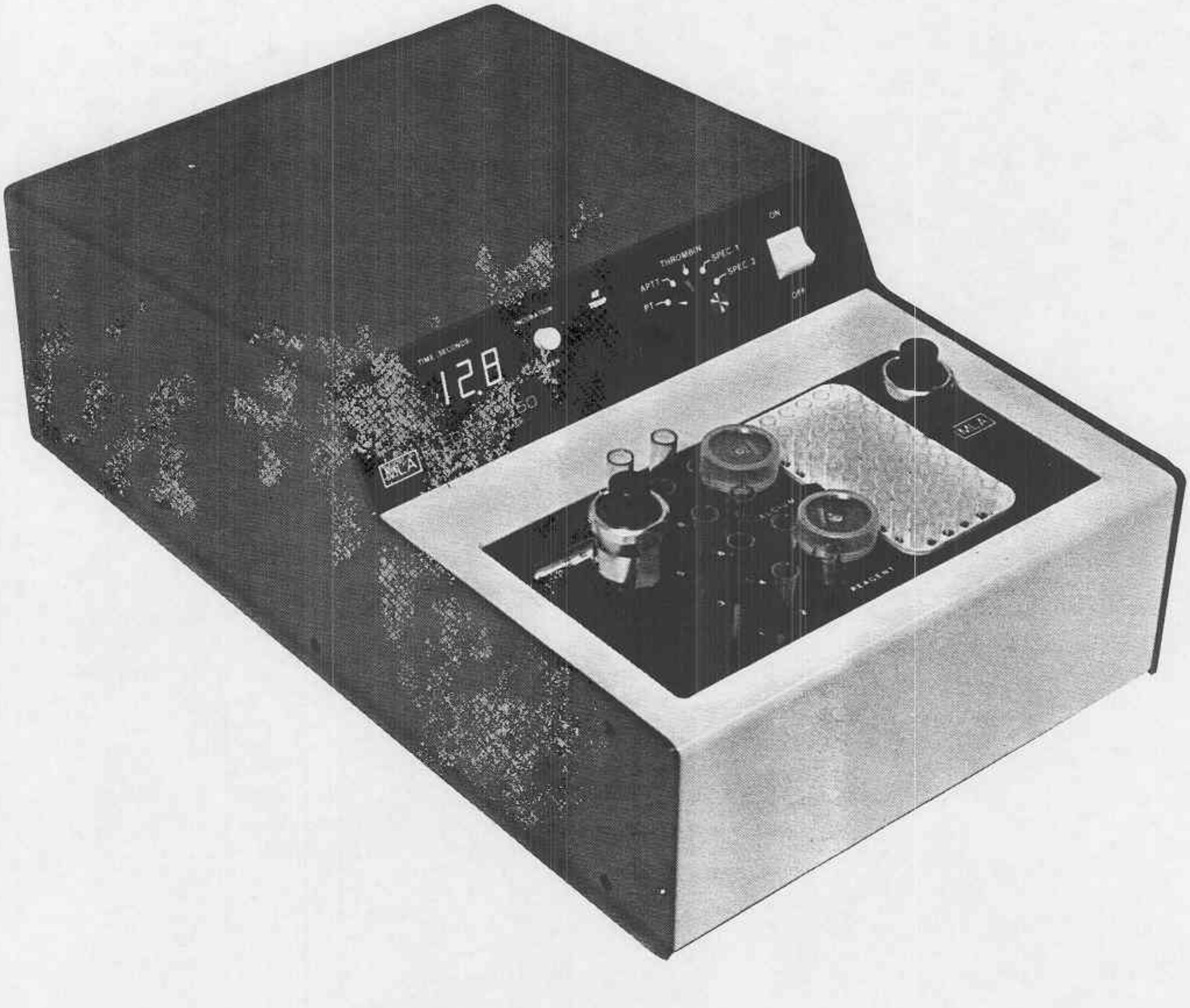
SERVICE MANUAL

ELECTRA 750


TIME SECONDS
12.8
INCUBATION
APTT
PT
THROMBIN
SPEC 1
SPEC 2
ON
OFF
MLA
REAGENT

MLA™
Medical Laboratory Automation, Inc.
270 Marble Avenue, Pleasantville, New York 10570-2982

MLA®
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270 Marble Avenue, Pleasantville, New York 10570-2982

PURPOSE

This manual is intended as an aid to service personnel in maintaining and repairing the Electra 750. Instructions on operating the equipment are contained in Operator's Manual No. 326364 (E750) or 326343 (E750A).

RE-ORDERING

Further copies of this manual can be obtained through the Technical Service Department at MLA, 270 Marble Avenue, Pleasantville, New York 10570-2982. The part number is 326158.

SERVICE ASSISTANCE

In the event of difficulty in tracing the cause of machine failure, MLA Technical Service Deparment should be contacted at:

Outside New York State	(800) 431-1720
Inside New York State	(800) 942-1405
Outside Continental U.S.	(914) 747-3020
Canada	(800) 255-4010

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SECTION 1

INTRODUCTION

1.1 GENERAL

The Electra 750 (E750) is a precision photo-optical Plasma Coagulation Timing Instrument that performs routine coagulation tests. In addition, the E750 performs Factor Assays, Quantitative Fibrinogen Assays a Thrombin Time method, and many other tests. The instrument works with citrate as well as oxalate collected systems. Reagents and controls produced by major manufacturers have been tested and can be used on the E750.

The patented Photometric method of endpoint detection introduced in earlier models of the Electra is used in this model. The E750 is the result of proven technology used for almost ten years in Coagulation Timing instruments manufactured by MLA.

The Photometric method utilizes the change in optical density of plasma to detect a clotting endpoint. When fibrin is formed in the plasma as a part of the coagulation process, the optical density increases. A photocell converts this change in optical density (O.D.) to an electronic signal, which is processed and compared to a reference level. When the processed O.D. signal exceeds a reference level, the clot is detected and the internal timing system displays the clot time on a front panel indicator.

Precise coagulation testing requires that the variable parameters influencing coagulation testing be precisely controlled. The MLA photometrics system offers some distinct advantages over other methodologies in this area. For example, crosscontamination is eliminated because nothing comes in contact with the specimen, nor influences the reaction. This is also a distinct safety feature because there is no possibility of operator contamination caused by manually cleaning probes inserted in the specimen under test.

The Electra's photo-optical system "looks at" the entire plasma sample and therefore can prevent errors due to foreign material in the sample or isolated fibrin strands that may be present in the plasma before the clotting test begins.

Many useful features have been added to the Electra 750 to provide easier, more accurate and precise measurements. Among these features are an "off-scale" indicator that lights if the optical system is out of range; a heating block that maintains ± 0.2°C regulation and warms all appliances used, even the pipette tips; a reagent reservoir with magnetic stirring, and special pipettes that automatically start the clot-timing circuitry when the reagent is added.

1.2 SCOPE OF MANUAL

This manual provides all of the necessary information required to operate, maintain, and repair the E750. This data has been included in the appropriately titled sections of the manual. We suggest that you become familiar with the contents of this manual in order to provide the best possible service for the instrument.

1.2.1 Introduction

Use of the E750 is described together with a functional and physical description.

1.2.2 Table of Specifications

Technical specifications and ranges of operation are listed here.

1.2.3 Unpacking and Packing

Information detailing how the E750 is packed together with a packing list. In addition, packing data is provided.

1.2.4 Installation

Installation procedures are provided for getting the E750 operational.

1.2.5 Operation

General operating procedure and techniques are provided in this section together with an explanation of the effect of outside influences on E750 results.

1.2.6 Theory of Operation

Functional descriptions of the overall system, analog, and digital circuits are provided in this section. Also included is introductory material describing basic technology together with logic symbols used in the E750 is presented.

1.2.7 Troubleshooting

Introductory approach to troubleshooting concepts is presented with tips on troubleshooting of digital circuits. In addition, a troubleshooting table and a list of anticipated voltages and waveforms are provided.

1.2.8 Coagulation Testing

Test protocols for specific tests are included here together with techniques of test preparation such as specimen collection and reagents used.

1.2.9 Maintenance Disassembly and Repairs

Preventive maintenance and repair procedures are included here together with a checklist for accomplishing the preventive maintenance task.

1.2.10 Adjustments

Procedures for accomplishing all of the field adjustments are presented here.

1.2.11 Schematic & Parts Location Diagrams/Parts List

Schematic of each major assembly is provided with a parts location diagram of that assembly together with a Parts List.

1.2.12 Warranty and Repair Policy

MLA's warranty statement is included here with a statement of replacement parts policy, return goods policy and ordering procedure.

1.3 DESCRIPTION

1.3.1 Functional

The E750 utilizes state-of-the-art analog and digital circuits to perform the primary functions of controlling temperature, counting time, and determining clot development. The temperature is controlled by an electronic sensing and switching circuit that maintains a heating block at a predetermined factory-set temperature. The power line frequency is used as a basis for timing and is developed through digital counting circuits to perform various functions at specified times in a predetermined sequence. The clot is sensed by passing light through it to observe its density characteristic. State-of-the-art analog techniques are used to process this signal to determine (1) when a clot signal develops and (2) if it is a legitimate clot.

1.3.2 Physical

The E750 is a self-contained instrument that is housed in a two-piece blue and white metal cabinet with a sloping front panel and a flat heated workstation directly in front of the front panel. All operating controls are on the front panel with seldom used switches on the rear panel with connectors for an optional printer and/or chart recorder.

Removal of the blue section of the cover automatically disconnects primary power from the circuits through an interlock switch that can be defeated for test purposes.

Modular construction is provided by three plug-in printed circuit boards, a plug-in power supply assembly, a cable plug-in heater block assembly, a cable plug-in display assembly; all of which, together with chassis mounted components, plug into a printed circuit mother board assembly. The entire instrument can be completely disassembled using standard tools.

SECTION 2

TABLE OF SPECIFICATIONS

ELECTRA 750

Physical

Size: 10 7/8" (27.6 cm) wide x 17 5/8" (44.9 cm) long x 6 3/4" (17.2 cm) high
Weight: 27.8 lbs. (12.6 kg)

Power Requirements

Max power dissipation (Heater ON): 115 watts
Input voltage ranges (internally selectable)
90 – 110 VAC
110 – 125 VAC
210 – 230 VAC
230 – 250 VAC
Line frequency: 50 or 60 HZ (rear panel switch selectable)
Fusing: for 90 – 125 VAC: 2A
for 210 – 230 VAC: 1A

Testing

Test Modes
PT
APTT
THROMBIN
SPEC 1
SPEC 2

Timer Resolution: 0.1 seconds
Maximum Time Readout: 999.9 seconds
Minimum Clot Time: This varies with the Mode

PT	7 seconds	
APTT	14 "	
THROMBIN	2 "	
SPEC 1	7 "	(E750A 2 seconds)
SPEC 2	14 "	

Test Method: Photo-optical clot detection.
Second derivative processing.

Test Performed: PT, APTT, Certain Factor Assays,
Quantitative Fibrinogen Assays,
and other Coagulation Tests. (See Section VIII.)

Test Performance: Performance varies greatly depending upon the test, method, reagents, etc. In clinical trials performed by MLA, coeffieients of variation of 0.5% for PT, and 0.6% for APTT were obtained. See Section VIII for notes on specific tests and procedures. Further data based on tests performed at MLA and in hospital labs, are available on request.

Reagents and controls produced by major manufacturers have been tested satisfactorily on the E750.

Incubation Timer

Resolution: 0.1 second
Operation: Push Button start/stop. Reset by test Cuvette in the test station.

Heater Block/Work Station

Temperature Regulation 37.2°C±0.2°C

Capacity: 10 Test Incubation Stations
2 Reagent Incubation Wells (One Reagent Well has Magnetic Stirrer)
50 Pipette Tips
2 Instrument Pipettes

AT TEMP Indicator: Lights when within ±0.3°C of factory set temperature
Range 25 – 45°C
Accuracy ±0.5°C from 30° to 40°C

Heater Block operational as long as unit is connected to main power.
Heater system protected by thermal fuse.

Instrument Pipettes

0.1 ml and 0.2 ml ±5%

Safety

Maximum leakage current to ground - 325 microamperes @ 120 volts, 25°C.
High voltage breakdown - withstands 1000 VAC from line to ground for 1 minute.

Radio Frequency Interference (RFI)

An RFI filter is included to minimize susceptibility and emission of RFI.

SECTION 3

UNPACKING AND REPACKING

3.1 UNPACKING

The Electra 750 is packaged in a single carton with a "Starter Kit". Unpack the instrument carefully noting position of materials. See Figure 3-1. Remove entire unit plus packaging by pulling straight up on the ends of the packing material. Separate packing material, taking care not to allow E750 to drop.

Note

SAVE ALL PACKING MATERIAL FOR USE IF REPACKING BECOMES NECESSARY. SHIPPING IN UNAUTHORIZED CONTAINER IS CAUSE FOR VOIDING WARRANTY.

Check packing list to determine that all items are included. Disposable supplies should be ordered immediately to avoid being without supplies when those in the starter kit are exhausted.

3.2 PACKING LIST FOR ELECTRA 750 – CATALOG NUMBER 1041
PACKING LIST FOR ELECTRA 750A – CATALOG NUMBER 1075

Your package should contain the following items.

QTY	DESCRIPTION	REORDER PART NO.
1	Coagulation Timer	A15E200
1	Instrument Manual	326144
1	Graph Pad	9041
1	Warranty Card	----
1 *	Pipette Tips in Tray	9620
1	Starter Kit, consisting of:	9052
80 *	Cuvettes	9005
100 *	Pipette Tips (Bulk Package)	#
1	0.1 ml Precision "D" Pipette	1055
1	0.1 ml Electra Pipette	1016
1	0.2 ml Electra Pipette	1017
1	Line cord	14992
1	Thermometer	A15A424
1	Magnetic Stirrer	9006
2	Beaker	9004
2	Beaker Cover	9008
1	Dust Cover	1049

* When these items are reordered, quantities larger than included in this kit are provided.

3.3 REPACKING

When the Electra 750 must be shipped, the same packing material in which the unit was received must be used. Prior to repacking, remove the workstation thermometer by sliding a piece of paper under the thermometer as shown in Figure 3-2 and pull straight up. Repack thermometer.

CAUTION

Workstation thermometer replacement will be at customer's expense if it breaks during shipment back to MLA. (Cost at printing – $30.00) When shipping to factory, include thermometer and pipettes.

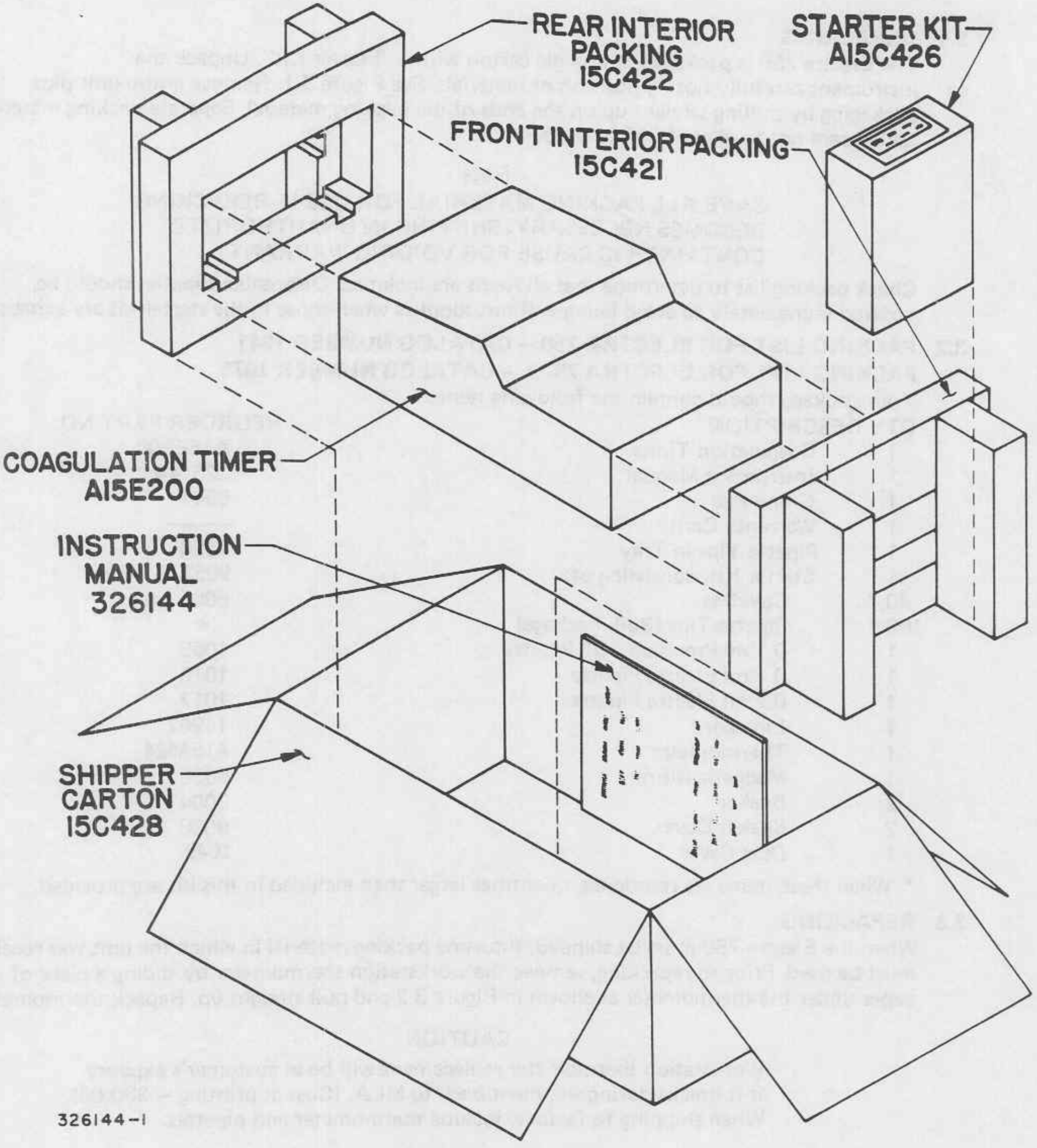

REAR INTERIOR PACKING 15C422
STARTER KIT AI5C426
FRONT INTERIOR PACKING 15C421
COAGULATION TIMER AI5E200
INSTRUCTION MANUAL 326144
SHIPPER CARTON 15C428
326144-1

Figure 3-1 Packaging for Electra 750

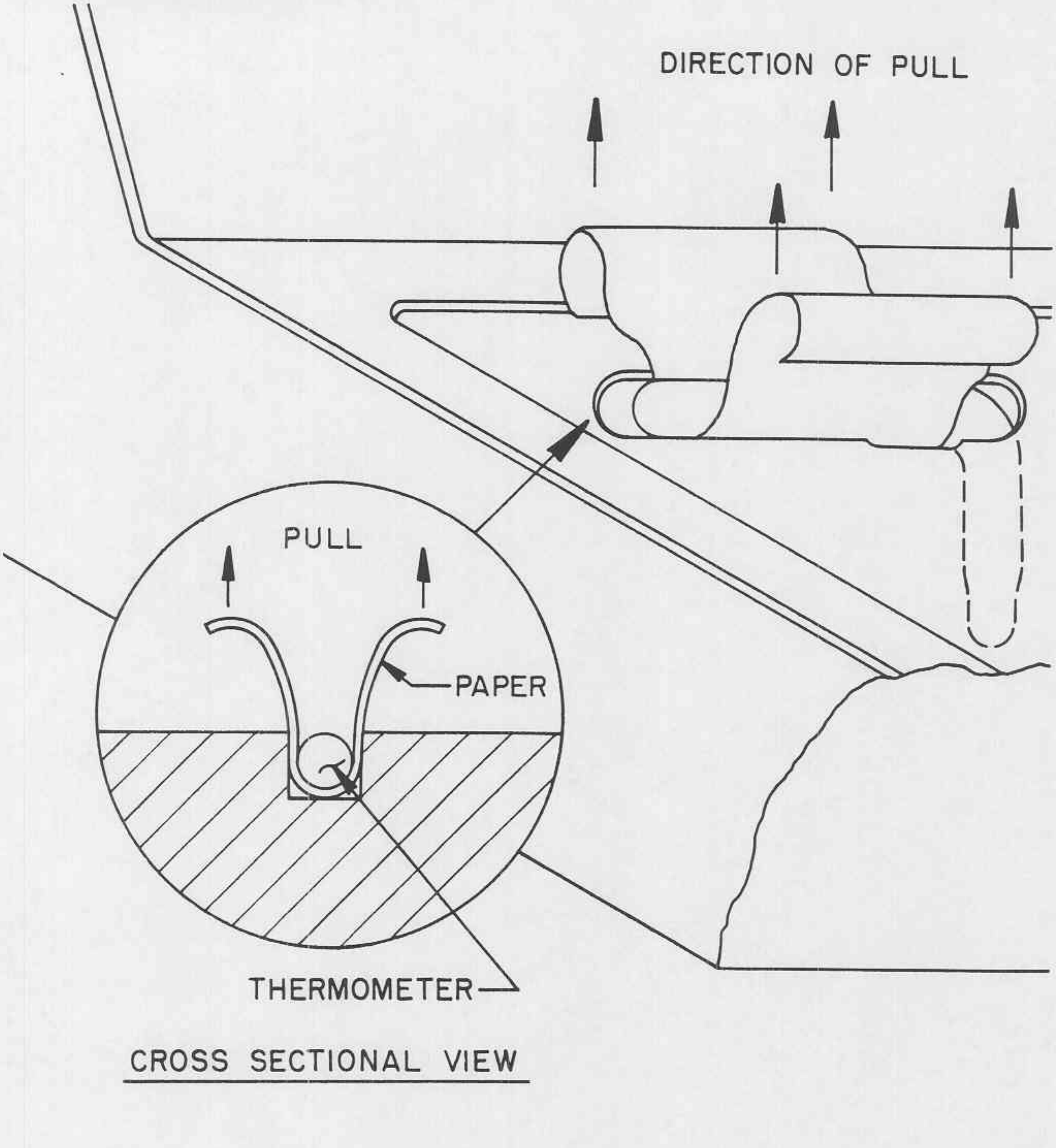

DIRECTION OF PULL
PULL
PAPER
THERMOMETER
CROSS SECTIONAL VIEW
326144-3

Figure 3-2 Removal of Workstation Thermometer

SECTION 4

INSTALLATION

4.1 INTRODUCTION

This installation section provides information covering the activities to be conducted prior to putting the instrument into service. These include an initial testing and confidence check procedure to insure that the instrument is working properly. Should a difficulty arise or an anticipated result is not obtained, refer to Section X, Troubleshooting.

Table 5 -1 Operating Controls, Indicators and Appliances should be consulted for use of controls and function of indicators prior to installation. (See Section V)

4.2 INSTRUMENT INITIAL SET-UP

The following one-time procedure must be performed after unpacking and prior to instrument use.

CAUTION

Before connecting unit to power source, check that power setting on rear panel agrees with power line voltage and frequency at your facility. If power available is unknown, check with your maintenance department to determine voltage and frequency.

4.2.1 Domestic U.S. models are normally shipped set up to operate on 110 -125 volts, 60 Hz, while overseas models are shipped to operate on 210 -230 volts, 50 Hz. If the line voltage or frequency at your facility is outside either range, the E750 may be adjusted for the additional ranges of 90 -110 V or 230 -250 V. If your line voltage is within range of the setting indicated on back panel, (See Figure 5.1) skip to step h. If it is not, perform steps a through g. If your line frequency is not the one indicated, use small screwdriver to set the Hz switch on the rear panel to the proper setting (either 50 or 60 Hz).

WARNING

Disconnect line cord before performing following steps to prevent exposure to lethal voltage.

a) Remove instrument cover by unscrewing 8 screws. Locate barrier strip on rear panel on right side. (See Figure 4 -1.)

b) Remove two hex nuts and fiber paper.

c) Loosen two screws holding shorting bar and remove shorting bar.

d) Place shorting bar in position so that the correct voltage range marking is visible through the cut-out in the rear panel.

e) Loosen associated barrier strip terminal screws and place shorting bar on required terminals and tighten screws.

f) Replace fiber paper and hex nuts.

g) Replace cover, check fuse value (should be 2A for 90 -125 or 1A for 210 -250), install power cord and connect to power source.

NOTE

Heater for incubation block is now operative and will begin to heat the block without operating power switch to ON.

h) Remove right angle thermometer from protective packaging and refer to Figure 4 -2. Install right angle thermometer in well on top left side of heating block, checking that it snaps into place.

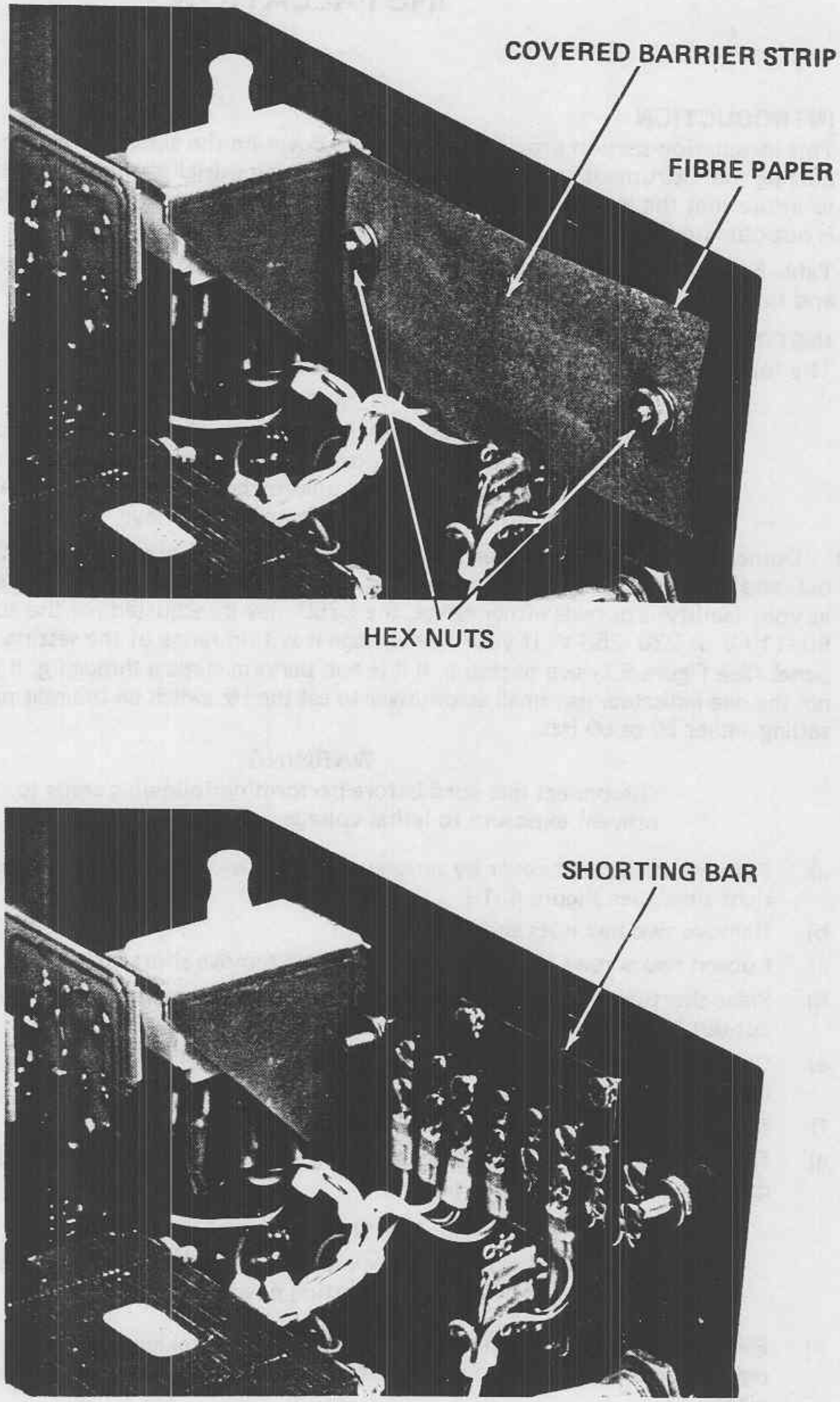

COVERED BARRIER STRIP
FIBRE PAPER
HEX NUTS
SHORTING BAR

Figure 4-1 Primary Voltage Adjustment Location

i) Set up work station by putting reservoirs, tips, cuvettes, and pipettes in place as shown in Figure 4-3. Magnetic stir bar will spin in "Reagent" reservoir only when power switch is set to ON.

j) Operate LAMP LEVEL switch on rear panel to B.

4.2.2 The E750 is provided with two special pipettes, a 0.1 ml and a 0.2 ml, two stainless steel reservoirs, an area for storing 50 disposable pipette tips. These items are contained in a heated area. The reservoirs are used to contain reagents and calcium and keep them at 37°C. The reagent reservoir has a magnetic stir bar that rotates to keep particulate reagents in suspension. The reservoirs are fitted with plastic covers to help maintain the temperature of its contents as well as to keep out foreign matter. Provision is made for a tray to hold 50 disposable pipette tips in the workstation. Pipette tips in prepackaged trays are available (Order No. 9620). Tips maintained, in these trays, in the heated area provide warm tips for aspirating warm reagents. This action provides greater accuracy by not cooling reagent prior to mixing with heated plasma under test. In addition, the E750 pipettes are heated. These pipettes are designed to fit the test station, dispense the reagent, and initiate clot timing when their plunger is pressed. These pipettes also provide a light shield for the specimen under test. All of these items are stored in the heated workstation whose temperature can be monitored on a thermometer mounted in the workstation.

4.3 INITIAL TESTING (OPERATOR CONFIDENCE TEST)

The Operator Confidence test provides a means by which the operator can determine that the instrument is performing in a satisfactory manner. It is recommended that this Confidence Test procedure be performed when Q.C. indicates a change has occurred.

4.3.1 Timer Check

a) Set the display panel "ON/OFF" switch to the "ON" position. The "TIME" display should read ".0" and when the heating block is up to temperature the "AT TEMP" light should illuminate

b) Depress the "INCUBATION TIMER" button to initiate display timing. Depress the "INCUBATION TIMER" button a second time to stop the display timing and reset the display to ".0".

c) Using the precision stopwatch, initiate the Incubation Timer and stopwatch simultaneously. Stop the stopwatch when the display reaches "60.0" seconds. Both the watch and the display should agree within the limits of your response time. Repeat as necessary.

d) Depress "INCUBATION TIMER" button to reset Display Time to ".0".

4.3.2 Logic Check

a) Depress the "INCUBATION TIMER" button to initiate display timing. Place an empty test cuvette into the Test Well. The Display Timer should reset to ".0".

b) Place an instrument pipette over the test cuvette in the Test Well. Select the "THROMBIN" Test Mode. Depress the pipette to initiate a clot timing sequence.
NOTE: If the "OFF SCALE" light goes on, then change the "ABC" lamp level switch to a different position (brighter or darker intensity) and repeat Step 4.3.2a until the display exceeds "2.0" seconds without an "OFF SCALE" indication.

c) While the ELECTRA 750 continues to time from Step 4.3.2b move the "ABC" lamp level switch to the "C" position (darker). The display should stop and hold the time of action.

d) Remove the pipette and cuvette from the Test Well. The display should retain the count obtained in Step 4.3.2.c.

e) Insert the empty test cuvette into the Test Well. The display should reset to ".0".

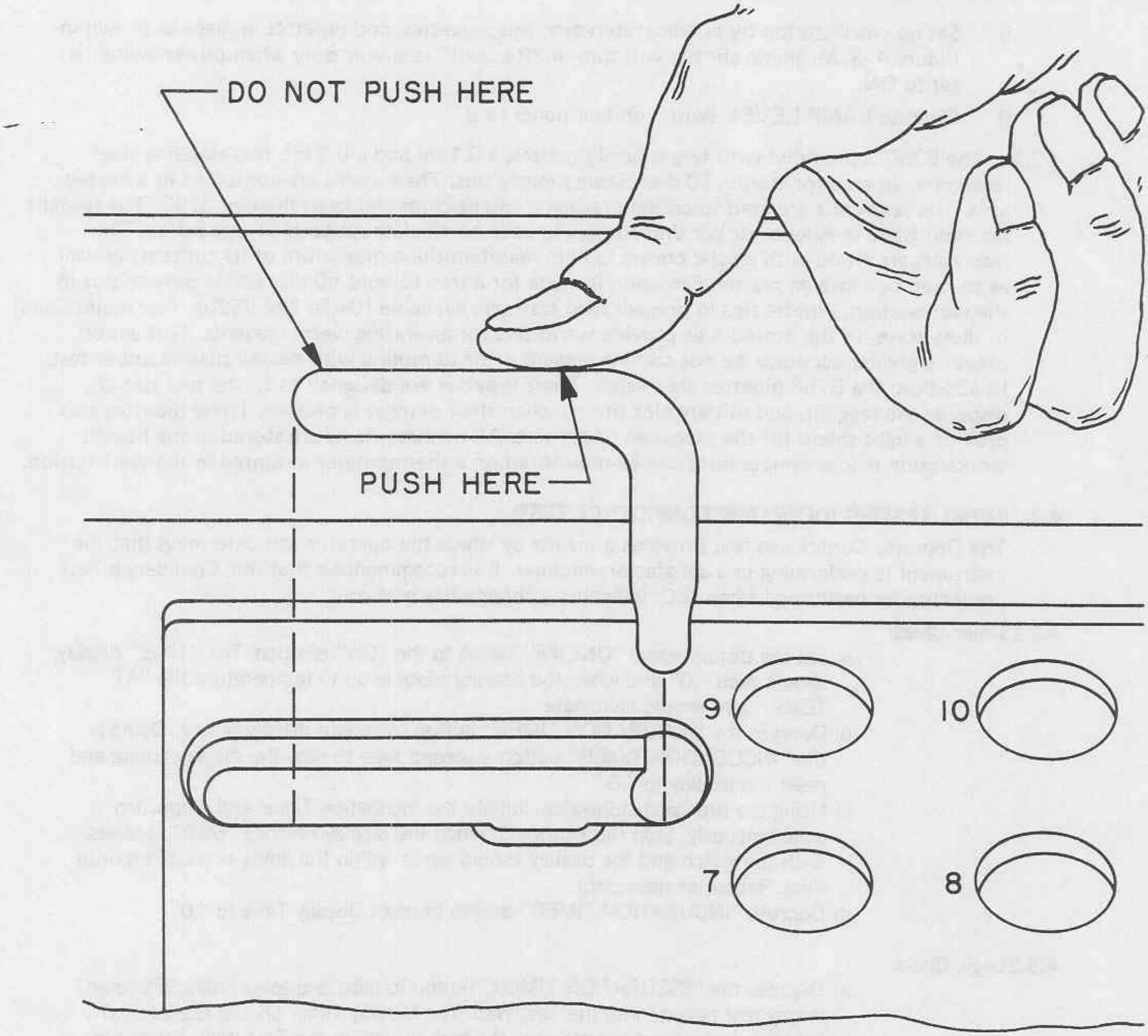
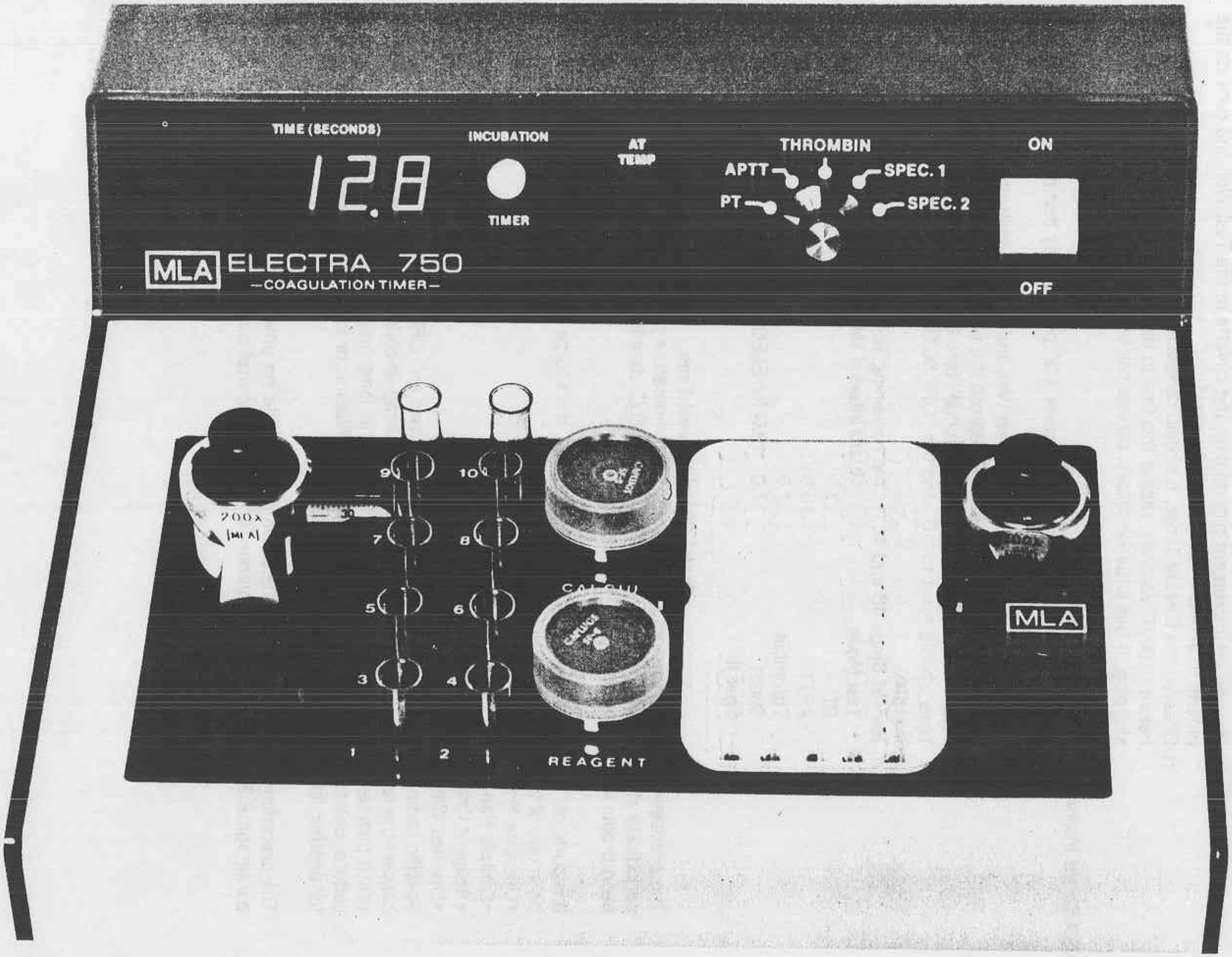

DO NOT PUSH HERE
PUSH HERE
9
10
7
8
326144-5

Figure 4-2 Installing Workstation Thermometer


TIME (SECONDS)
12.8
INCUBATION
TIMER
AT TEMP
THROMBIN
APTT
PT
SPEC. 1
SPEC. 2
ON
OFF
MLA ELECTRA 750
—COAGULATION TIMER—
200λ
MLA
9
10
7
8
5
6
3
4
1
2
REAGENT
MLA

326144-6

Figure 4-3 Electra 750 Workstation

4.3.3 Optical Noise Check

a) Insert an empty test cuvette into the Test Well, select the lamp level used in Step 2.b, and select the "THROMBIN" Test Mode.

b) Position an instrument pipette over the cuvette in the Test Well and depress the pipette to initiate a clot observation test.

c) Observe the Display Timer. It should continue to time indefinitely. If timing stops before "100.0" seconds, repeat this test to determine the persistence of stopping. If this situation arises, service will be needed to repair cause.

4.3.4 Guard Interval Timer Check

a) Compress a facial tissue into the lower 1/2" of an empty test cuvette to make it opaque (Dark Cuvette).

b) Insert the Dark Cuvette into the Test Well and place an instrument pipette over it.

c) Select the "PT" Test Mode and depress the pipette to start a clot observation test. At the end of the "Guard Interval" (see Guard Interval Time Table) the timer should reset to ".0" and the "OFF SCALE" lamp should light. Remove cuvette.

d) Repeat Steps 4b and 4c for the remaining Test Modes

Test Mode	Guard Interval Time Seconds
PT	7.0
APTT	16.0
Thrombin	2.0
Spec I	7.0 (2.0 for ELECTRA 750A)
Spec II	16.0

Table, Guard Interval Time

The precision of both instrument pipettes, and the temperature of the heater block should be periodically checked. No further checks are needed if Q.C. data indicates the ELECTRA 750 has been producing satisfactory times and duplicating well.

If reports of "wrong" or "erratic" test results persist, the source of this coagulation concern could be in one of the following areas:

- Operator Procedures
- Sample Handling
- Reagent Characteristics
- Distilled Water Characteristics

Specific testing procedures (PT, APTT, etc.) may produce an "OFF SCALE" indication. If this should happen the test procedure should be repeated in all lamp levels (A, B & C). Select the lamp level which provides the best QC test results. Remain in this lamp level for all tests of the same procedure, unless there is a unique quality of specimen (lipemic or icteric) which necessitates the need for another lamp level.

The preceding activity constitutes the preliminary installation procedure. Refer to Section V, then to paragraph 8.3 to perform a Prothrombin Time Test on control plasmas to complete the installation.

SECTION 5

OPERATION

5.1 INTRODUCTION

This section covers the general operation of the instrument. Refer to Section VIII, Coagulation Testing, for specific tests and procedures for each test.

5.2 CONTROLS, INDICATORS, AND APPLIANCES

Table 5 - 1 describes the function of E750 controls, and appliances. Figure 5 - 1 shows location of these controls, indicators, and appliances. (Table 5 - 1 and Figure 5 - 1 are at the end of the section)

5.3 INSTRUMENT TURN-ON

The instrument turn-on procedure is an abbreviated Operator Confidence Test, and can be conducted by performing the following steps:

a) Operate ON-OFF switch to ON, lamp level switch to B, mode select switch to PT, and check that AT TEMP indicator is lit.

b) Place empty cuvette and instrument pipette in place at test station, and press pipette plunger. Check that OFF SCALE indicator remains extinguished for at least 10 seconds as indicated on TIME display.

c) Remove and reinsert empty cuvette, replace instrument pipette, operate lamp level switch to A, and press pipette plunger. Check that: OFF SCALE indicator lights after approximately 7 seconds, and TIME indicator automatically resets to 0 after the count. If OFF SCALE indicator does not light, photolamp may be aging. See paragraph 10 - 1.

d) Check that workstation thermometer indicates 37°C ±0.5°C.

e) Wait for 5-minute warmup period prior to performing any test procedures of Section VIII.

5.4 PREPARATION FOR TEST

Prepare the instrument for testing by performing the following steps.

a) Place sufficient amount of reagent in reservoir. Keep covered to maintain temperature. Allow 20 minutes per 10 ml for heating to 37°C.

NOTE

Only REAGENT reservoir has magnetic stir bar for particulate reagent that require continual mixing.

b) Place tray of MLA disposable tips in position shown in Figure 5 - 1. These tips will be heated and should be used in aspirating reagent and calcium for tests.

c) Select mode of operation.

d) Incubate sample by placing specimen under test in incubation station at staggered intervals to provide incubation for length of time specified by type of test. Time for the normal sample to clot plus time required to remove clotted specimen and replace with another specimen is stagger interval. This action prevents over incubation of specimens tested. Incubation timer may be used to time incubation period.

e) After incubation, place sample in test station, pushing cuvette to bottom of test well. This action will reset timer to zero if it was being used to time incubation period.

f) Using appropriate E750 pipette (red or blue cap), pick up prewarmed disposable pipette tip, aspirate reagent and place over cuvette in the test station. Align pipette to have flat side containing marking towards you.

g) Push plunger firmly and hold down for one second, then release plunger. LEAVE PIPETTE IN PLACE UNTIL TEST IS COMPLETED. DO NOT DISTURB PIPETTE DURING TEST.

h) Watch completion as indicated by timer displaying a fixed number. If during test, OFF SCALE indicator lights, remove sample from test station and observe its density. If this sample appears more opaque or darker than previous successively run samples, operate LAMP LEVEL switch on rear panel to B or A to increase brightness of lamp. If sample appears more transparent or lighter than previous successively run samples, operate LAMP LEVEL switch on rear panel to B or C to reduce brightness of lamp. If OFF SCALE indicator continues to light, photolamp replacement may be required, Refer to Section X, Maintenance.

NOTE

When the OFF SCALE indicator lights, the specimen under test is outside the range of the scale on which the instrument is operating. The density of this specimen is either too dark (dense) or too light (transparent). When this occurs, the timer will reset to zero. For an off-scale condition, the OFF SCALE indicator will light at some interval of time after the start of the test, depending on the mode of operation. See chart below:

Mode	Time (seconds)
PT	7
APTT	16
THROMBIN	2
SPEC. 1	7
SPEC. 2	16

i) Upon completion of test, record clot time and discard cuvette and pipette tip.

CAUTION

Use a clean disposable tip on a blue or red topped instrument pipette for each pipette for each test, to prevent sample carryovers to the reagent reservoir.

NOTE

Inserting next specimen will reset timer to zero automatically.

5.5 CONSIDERATIONS PRIOR TO TESTING

There are areas of activity that influence the results obtained in tests performed by the instrument. These activities fall into three major categories: (1) Materials used, (2) Operator techniques and (3) Instrument status.

5.5.1 Material Impact on Clot Times

Pipettes (Defective pipettes or tips that cause improper volume dispensing, will alter clot times.

Improperly Washed Test Tubes

Those operations that reuse the "disposable" test tubes by washing, will hazard having detergent remnants left in tubes, which will have a destructive effect on plasma samples, leading to altered and erratic clot times.

Aging Reagents

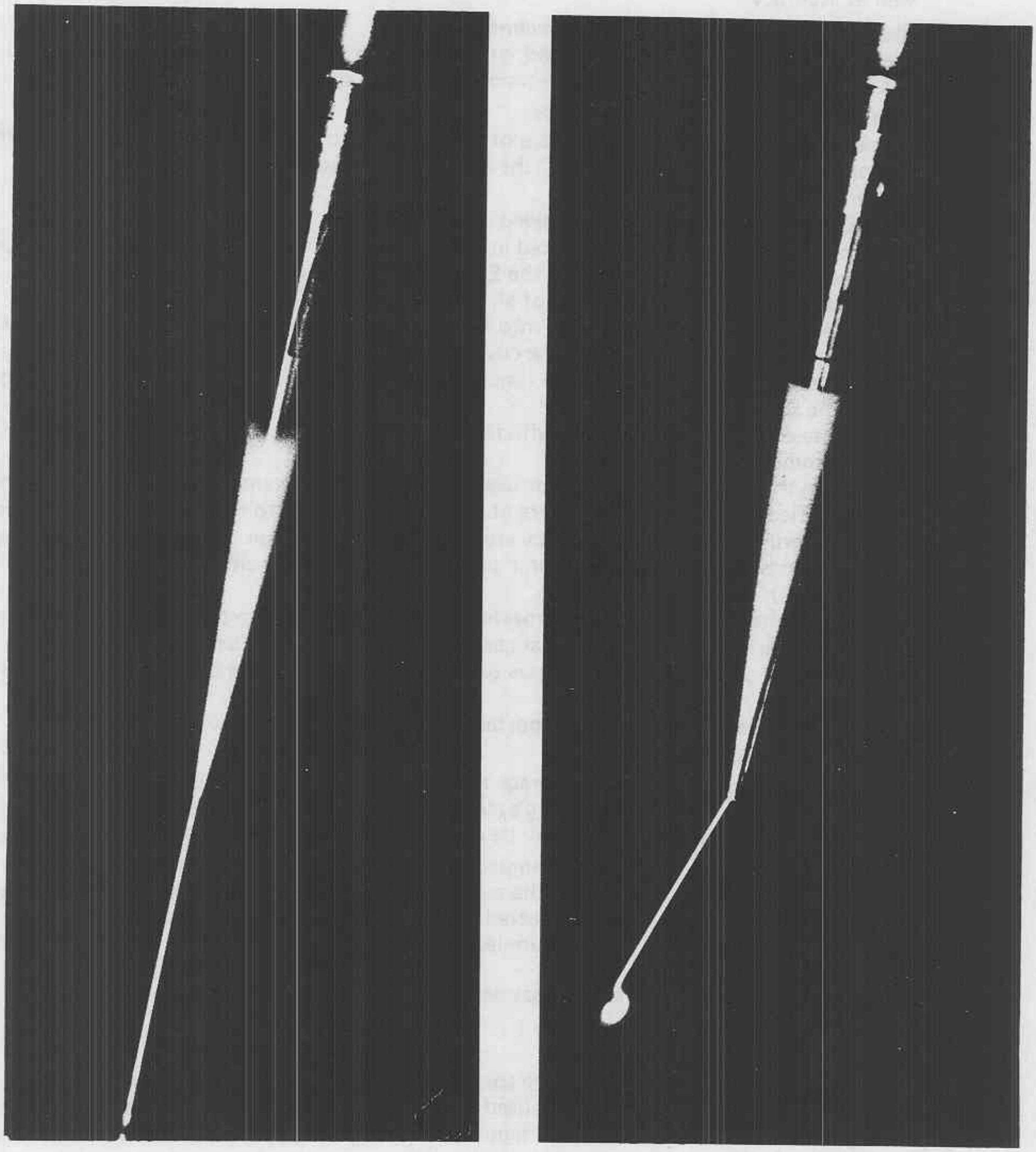
Frequently, reagents are improperly stored, or exceed their manufacturer's shelf life specifications. Aging or defective reagents generally prolong clot times and can cause poor duplicate times on replicates.

Control Time Deviations From Lot to Lot

The Electra sensitivity is such that time differences between lots of controls are exposed. Controls are also subject to improper storage and aging, just as reagents, with the resulting deterioration in clot time levels and uniformity of times in duplicates.

PIPETTE TIPS

Pipette Tips play an important role in the proper operation of the 750. The mixing action between the patient plasma and reagent is performed by the stream of reagent from the pipette tip. A good stream is shown in Figure 5 -2A. When this stream is not directed into the bottom of the tube (see Figure 5 -2B) due to a poor quality tip, improper mixing occurs and the clot time is adversely effected. MLA 9620 Tips are designed and quality controlled to provide this proper mixing action. Use only MLA Tips for best results.



A – MLA TIP

B – BRAND "X" TIP

Figure 5 -2. Pipette Tip Quality Comparision

Ph Levels of Bio Materials

a) Distilled water used in reconstituting bio materials must be of proper purity and Ph level.

b) Similarly, salines used in dilution preparations must have the proper Ph level. (Several installations have reported that the use of "buffered" salines have corrected otherwise unsatisfactory clot time results.)

c) Blood drawing tubes are subject to deterioration which alters the optimum Ph level.

d) In all circumstances, improper Ph levels will seriously alter the clot time precision as well as accuracy.

Inadequate Centrifuging of Patient Specimens

Specimens must be adequately centrifuged, otherwise both the precision and accuracy of replicate times are materially altered. Specimens should be spun for 15 minutes at 1000g.

Optical Considerations of Bio Materials

Some types of reagents, such as Kaolin, are of such dense nature as to exceed the ability of the Electra's optical system to "see through" the specimens. Consequently, such material is not suitable for use on the Electra.

5.5.2 The Operator Impact on Electra Reported Clot Times

The handling of bio materials has a marked impact on clotting times more so on dilution type tests, such as APTT. It is important that the Electra operator will do the following:

1. Pipette precise and correct quantities of all bio material.
2. Pipette specimen and reagent directly into the bottom of the test cuvette. (Sample should not be discharged along the sides of the cuvette.)
3. Provide uniform and exact incubation times, according to MLA Operator's Manual. Section VIII, for the specific test.
4. Reconstitute controls in accordance with manufacturer's instructions and allow to stand for at least 15 minutes.
5. Make certain that reagents specified for use at 37°C be at that temperature. (Cold reagents placed into Electra reservoir will require at least 20-30 minutes to reach operating temperatures,)
6. Use controls only on tests for which they are designed. (For example, some controls are suitable only for PT tests – though manufacturer's literature may not specifically deny their use on APTT tests.)
7. Do not locate the Electra adjacent to machines that can generate extraordinary line surges, or electrical interference. Machines that cause high vibration levels should be kept remote from the Electra. Electras are impervious to reasonable disturbances produced by unbalanced centrifuges.

5.5.3 The Instrument Impact on Electra Reported Clot Times

Improper Temperature Levels

Incubation temperatures and reagent storage temperatures are determined by a temperature controller that maintains the tube heating system and the reservoir storage at proper levels that will assure that the test specimen will be at 37°C during the test cycle.

Although the system may be at proper temperature, the following circumstances can cause improper incubation duration, or cause the specimen or reagent not to be at proper temperature levels, which will consequently alter expected clot times.

a) Reagents are not up to temperature levels because "cold"reagents were put into the reservoir

b) Duration of incubation interval has been altered by the operator from those prescribed in the Operator's Manual.

Improper Bio Volumes

The ratio of plasma to reagents in clotting specimens will have a marked effect on resulting clot times. If either the pipetting devices used in preparing the specimens, or the device dispensing the reagent (or both) deviates significantly from the prescribed volume, clot times can be either prolonged or foreshortened significantly.

The pipette supplied with the Electra together with a proper MLA tip, are calibrated to deliver 0.1 ml or 0.2 ml with an accuracy of ±5% with a precision of better than ±5%. A defective pipette or defective tip, can alter the proper volume or the quality of the injection stream which will have some impact on clot time accuracy.

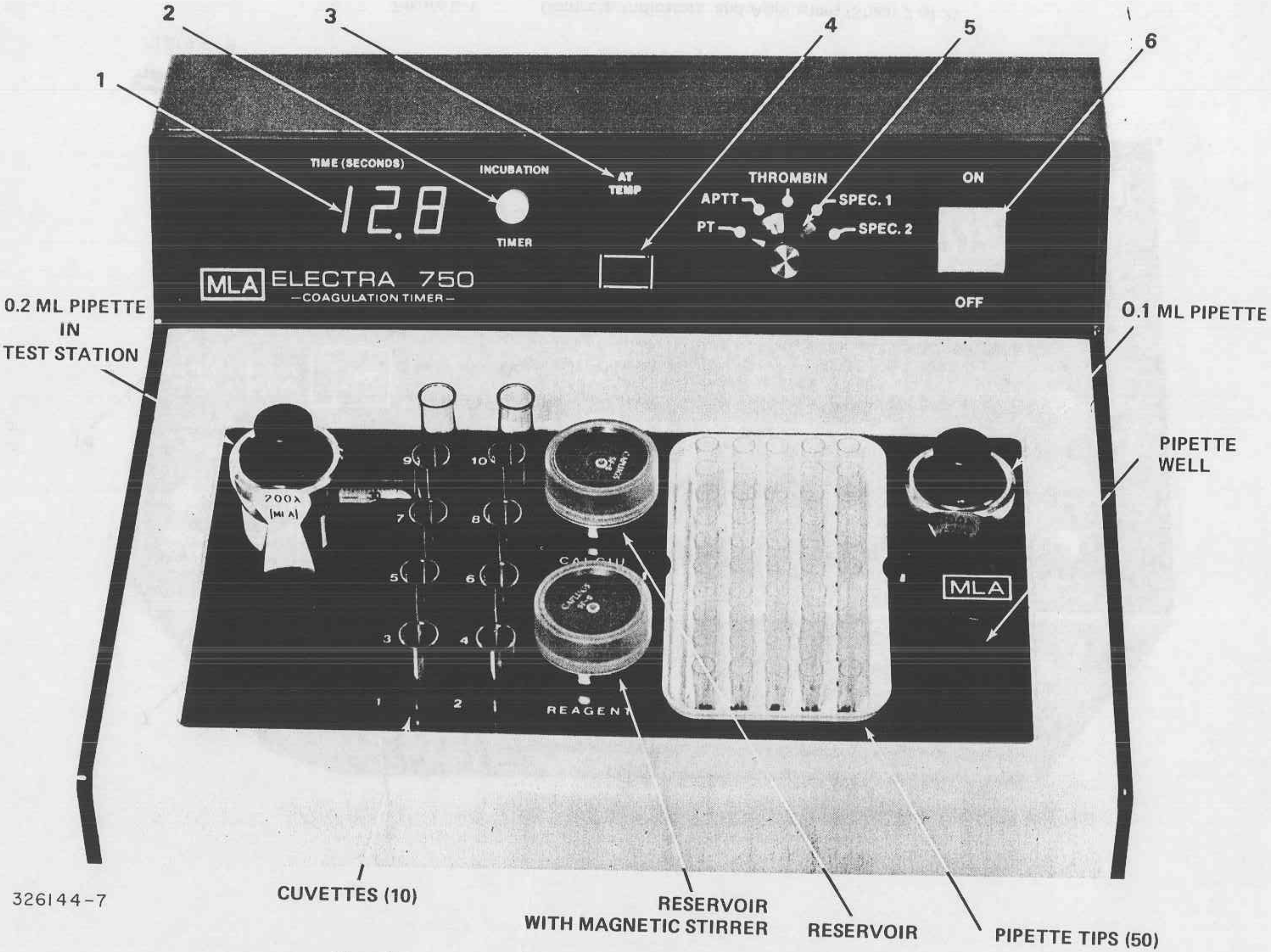
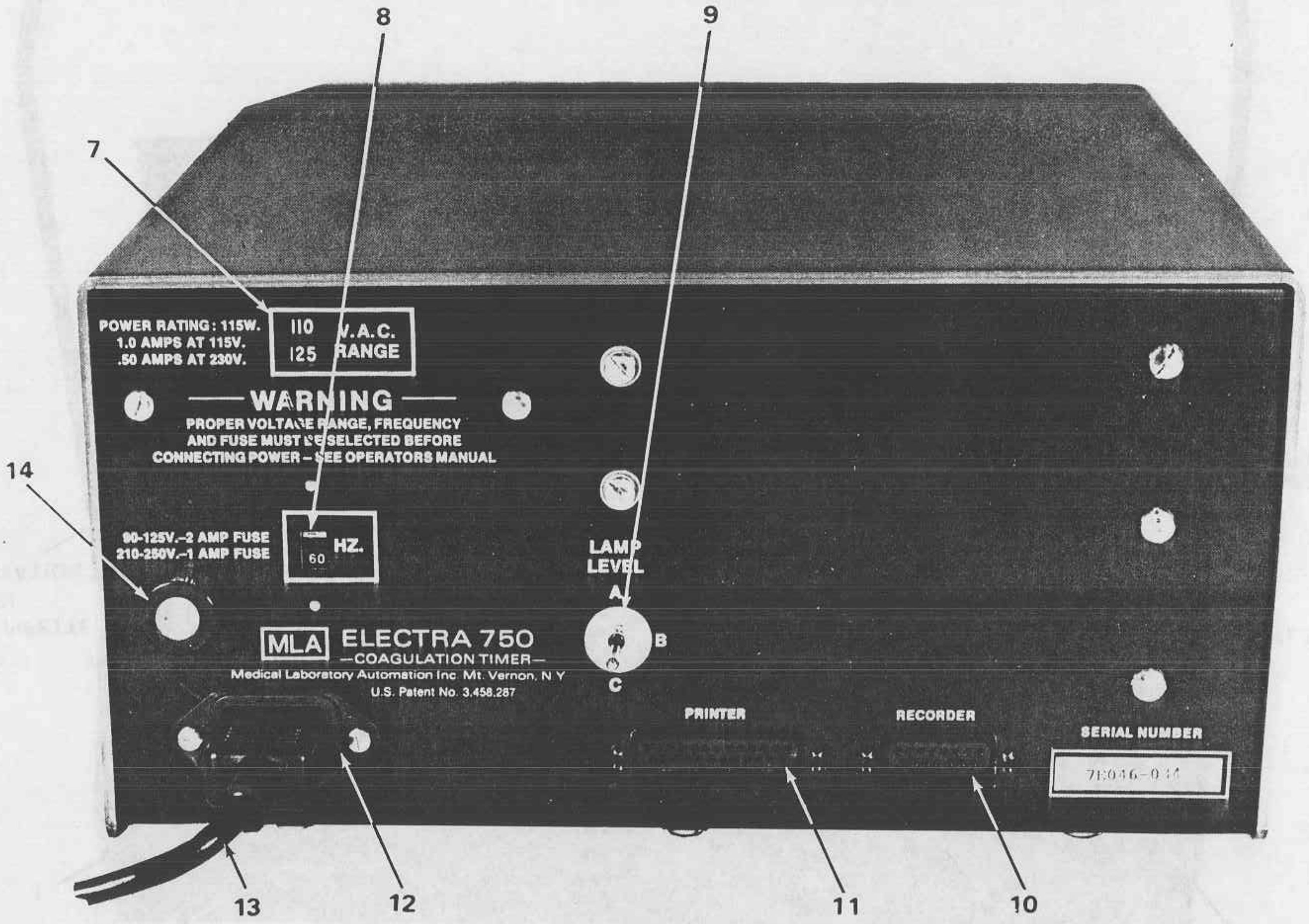

1
2
3
4
5
6
TIME (SECONDS)
12.8
INCUBATION
TIMER
AT TEMP
THROMBIN
APTT
SPEC. 1
PT
SPEC. 2
ON
OFF
MLA ELECTRA 750
—COAGULATION TIMER—
0.2 ML PIPETTE IN TEST STATION
0.1 ML PIPETTE
PIPETTE WELL
200λ
MLA
CALCIU
REAGENT
MLA
326144-7
CUVETTES (10)
RESERVOIR WITH MAGNETIC STIRRER
RESERVOIR
PIPETTE TIPS (50)

Figure 5-1 Controls, Indicators, and Appliances (Sheet 1 of 2)


7
8
9
14
POWER RATING: 115W.
1.0 AMPS AT 115V.
.50 AMPS AT 230V.
110
125
V.A.C.
RANGE
WARNING
PROPER VOLTAGE RANGE, FREQUENCY
AND FUSE MUST BE SELECTED BEFORE
CONNECTING POWER – SEE OPERATORS MANUAL
90-125V.-2 AMP FUSE
210-250V.-1 AMP FUSE
60
HZ.
LAMP
LEVEL
A
B
C
MLA
ELECTRA 750
—COAGULATION TIMER—
Medical Laboratory Automation Inc. Mt. Vernon, N.Y.
U.S. Patent No. 3.458.287
PRINTER
RECORDER
SERIAL NUMBER
7E036-034
13
12
11
10

326144-8

Figure 5-1 Controls, Indicators, and Appliances (Sheet 2 of 2)

Table 5 - 1. OPERATING CONTROLS, INDICATORS, AND APPLIANCES

FRONT PANEL			
Key	Panel Marking	Description	Function
1	TIME (SECONDS)	Display	Display clot time or time of incubation
2	INCUBATION TIME	Pushbutton Switch	Starts and stops timing when there is no tube in the test station. When timing is stopped, display automatically resets to zero ("0")
3	AT TEMP	Indicator	Lights when incubation heating block temperature is at factory set level (37°±0.3°).
4	OFF SCALE	Indicator	Lights when plasma density is such that clots will not be detected due to out of range condition. Either too dense or too Transparent.
5	MODE SWITCH	Rotary switch	Determines mode of operation:
	PT		Prothrombin Time Test
	APTT		Activated Partial Thromboplastin Time Test
	THROMBIN		Thrombin and Fibrinogen Tests
	SPEC. 1		Provides special test parameters to be used as designated by MLA representative or distributor's salesman.
	SPEC. 2		Same as above for SPEC. 1
6	ON-OFF	Rocker switch	Provides initial primary power to the instrument.

REAR PANEL			
Key	Panel Marking	Description	Function
7	V.A.C. RANGE	Window for jumper position indicator	Indicates the range of primary voltage: 90-100, 110-125, 210-230, 230-250,
8	HZ	Slide switch	Indicates switch position of primary power frequency, which is either 50 or 60 HZ

REAR PANEL (Con't)			
Key	Panel Marking	Description	Function
9	LAMP LEVEL A B C	Toggle	Adjust intensity of Photolamp to one of three levels: A – Brighter B – Medium C – Dimmer
10	RECORDER	Connector (15-pin)	Provides connection for attaching a strip chart recorder to record the excursions of the denisty and E4 signal
11	PRINTER	Connector (25-pin)	Provides a connection for producing hard copy data out on MLA optional printer
12	AC CONNECTOR	Connector	Provides for application of primary power
13	AC LINE CORD	Cable	Provides for application of primary power
14	FUSE 1A 2A	Fuseholder	Provides current protection For 210 to 250 volts For 90 to 125 volts

WORK STATION		
Item	Description	Function
Thermometer	Mercury glass thermometer	Indicates temperature of incubation block
Test Station	Well for inserting test specimen	Test well for aligning specimens in light path to determine clot time
Incubation Stations	10 holes in heating block	10 stations for heating specimens prior to testing
Cuvettes	Plastic 10x75 tubes with flat bottom. Available as MLA Part No. 9005	Contain plasma under test for incubation and testing.
Reservoirs	Stainless steel container with plastic top. Only REAGENT container is outfitted with magnetic stir bar.	Holds reagent and calcium for tests.

WORK STATION (Con't)		
Item	**Description**	**Function**
Disposable Tips	MLA disposable tips in 50 - count tray (MLA Part No. 9620	Holds disposable tips in a heated area to provide warm tips
E750 Pipettes	Blue Cap - 0.1 ml short pipette and Red Cap - 0.2 ml short pipette.	Provides means of aspirating and dispensing reagent, starting clot timing, and providing a light shield for specimen under test. Must be used to initiate test and remain in place during test.
Pipette Well	Two holes in heated workstation to hold pipettes	To hold and maintain pipettes at approximately 37°C

SECTION 6

THEORY OF OPERATION

6.1 INTRODUCTION

The E750 is a precision photo-optical Plasma Coagulation Timing Instrument that performs routine coagulation tests by observing the change in optical density that occurs as a plasma sample clot. The E750 processes this optical density signal, times the clotting and displays the clot time on a 7-segment readout. The E750 also provides a controlled dry heat bath for specimens under test and reagents. To perform these functions, the E750 utilizes both analog and digital circuitry.

The analog circuitry consists primarily of operational amplifiers, a heater control circuit, and power supplies. The digital circuits are primarily standard CMOS IC'S. There is also one LSI IC used for the timing and display.

This chapter provides an overall functional block diagram of the E750, subordinate block diagrams, and simplified circuits for the various major functional units. Also provided (paragraph 6.2) is a general review of digital circuit theory and logic.

For specific problems, Section 7 provides a troubleshooting guide and Section 9 provides disassembly and repair information. Consult Section 9 before making any repairs.

6.2 GENERAL DIGITAL THEORY AND LOGIC

6.2.1 INTRODUCTION

The information presented here is not intended to be a digital logic course. However, a sufficient amount of information is included to aid in understanding the circuits employed in the E750 to perform logic functions. Where additional information is desired, consult manufacturer's literature covering the device of interest.

6.2.2 LOGIC CIRCUITS

Three basic circuits are used in the E750 together with several specialized circuits, all of which are described here. When appropriate, a truth table is presented with the symbol; in other cases a timing diagram is presented. The symbol + is used to represent an OR-function and a dot • is used to represent an AND function. These functions are shown below with other more complicated logic operations.

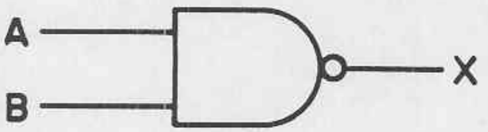
The high/low or 1/0 states are defined in the E750 as +12 VDC and O VDC, respectively. However, switching functions can be accomplished when the high level reaches as low as +9 VDC or the low level reaches as high as +3 VDC.

GATES

There are two primary gates employed in the E750 together with an electronic switch. These gates are standard NAND and NOR gates. Both two-input and three-input NAND gates are used in the E750.

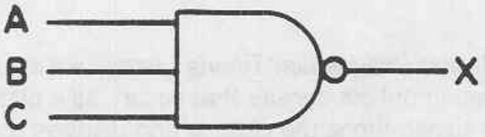
NAND Gate

A NAND gate provides a high (1) output when either or both inputs are low (0) or a low output when both inputs are high. There are four gates in each IC chip.



A	B	X
L	L	H
L	H	H
H	L	H
H	H	L

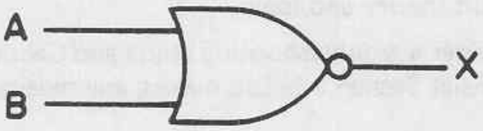
The three input NAND gate functions the same as the two-input NAND gate, any low gives a high output, all highs give a low. There are three gates in each IC chip.



A	B	C	X
L	L	L	H
L	L	H	H
L	H	L	H
H	L	L	H
H	L	H	H
H	H	L	H
H	H	H	L

NOR GATE

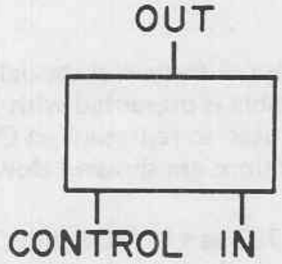
A NOR gate provides a low (0) output when either or both inputs are high (1) or a high output when both inputs are low. There are four gates in each IC chip.



A	B	X
L	L	H
L	H	L
H	L	L
H	H	L

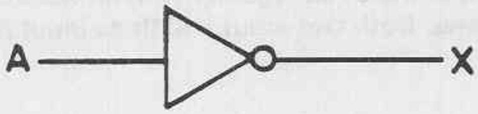
Electronic Switch

The electronic switch provides a closed circuit when a high (1) is applied to the control input or an open circuit when a low (0) is applied to the control input. Four switches are included in each IC chip.



Control	Switch
1	ON
0	OFF

Inverter provides the complement of the input at the output. Six inverters are included in each IC chip.



A	X
1	0
0	1

SPECIALIZED LOGIC CIRCUITS

There are other logic circuits used to perform special functions. These circuits and their functions are discussed below.

D–Type Flip–Flop

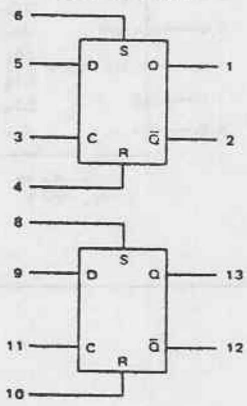
This type of flip-flop provides the D input at the Q output when the positive edge of the clock pulse is applied. In addition, direct set and reset functions are available. The IC contains two flip-flops.

TRUTH TABLE

INPUTS				OUTPUTS		
CLOCK†	DATA	RESET	SET	Q	$\bar{Q}$	
↑	0	0	0	0	1	
↑	1	0	0	1	0	
↓	X	0	0	Q	$\bar{Q}$	No Change
X	X	1	0	0	1	
X	X	0	1	1	0	
X	X	1	1	1	1	

X = Don't Care
† = Level Change

BLOCK DIAGRAM


6
5
D
S
Q
1
3
C
R
$\bar{Q}$
2
4
8
9
D
S
Q
13
11
C
R
$\bar{Q}$
12
10

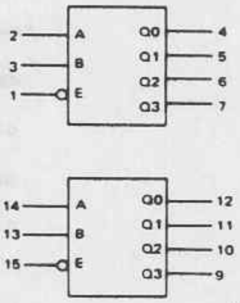
Binary to 1 of 4 Decoder

This circuit decodes a binary number applied to the A and B inputs when the enable line is low, to provide a high level on one of four output lines. There are two decoders in each IC chip

TRUTH TABLE

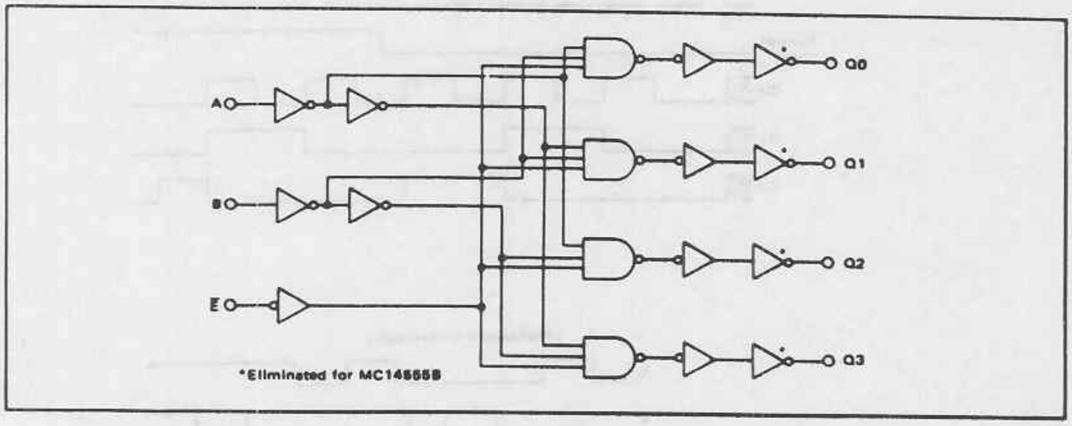
INPUTS			OUTPUTS MC14555B				OUTPUTS MC14556B			
ENABLE	SELECT									
$\bar{E}$	B	A	Q3	Q2	Q1	Q0	$\bar{Q}3$	$\bar{Q}2$	$\bar{Q}1$	$\bar{Q}0$
0	0	0	0	0	0	1	1	1	1	0
0	0	1	0	0	1	0	1	1	0	1
0	1	0	0	1	0	0	1	0	1	1
0	1	1	1	0	0	0	0	1	1	1
1	X	X	0	0	0	0	1	1	1	1

X Don't Care


2
A
Q0
4
3
B
Q1
5
1
E
Q2
6
Q3
7
14
A
Q0
12
13
B
Q1
11
15
E
Q2
10
Q3
9

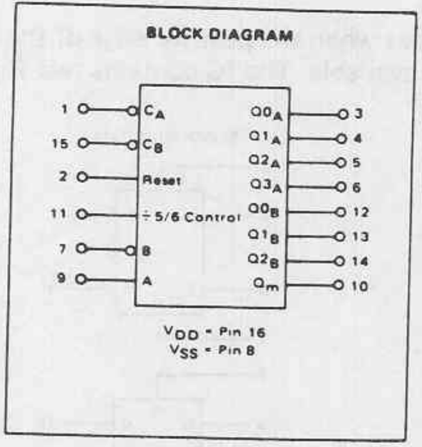
V_{DD} = Pin 16
V_{SS} = Pin 8

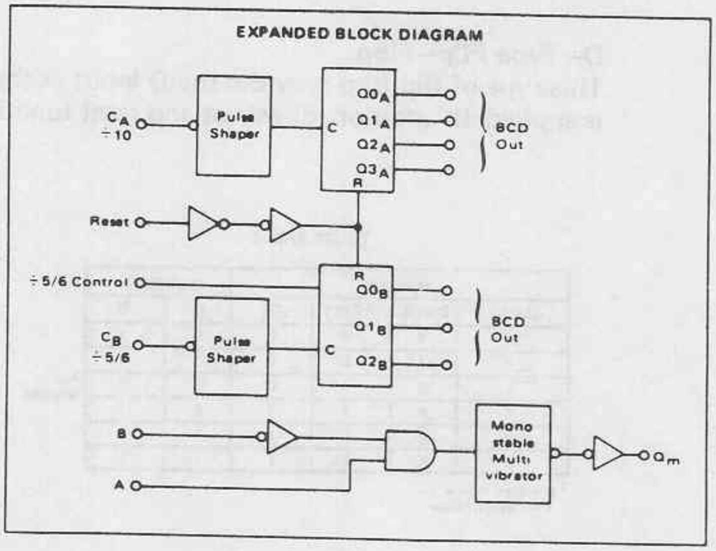
LOGIC DIAGRAM
(1/2 of Dual)


A
B
E
Q0
Q1
Q2
Q3
*Eliminated for MC14555B

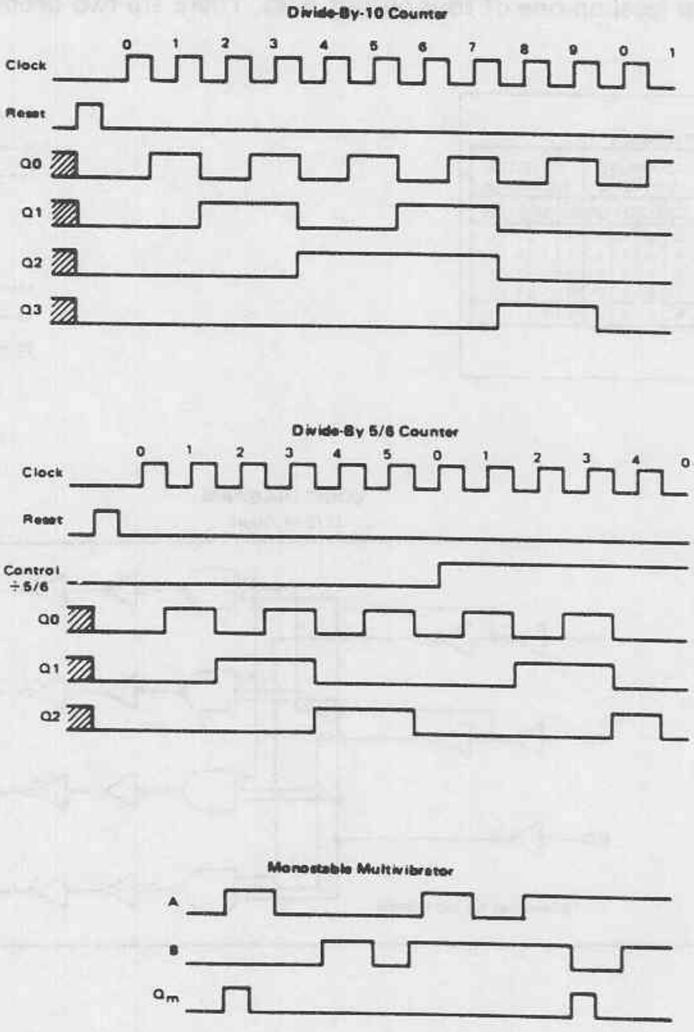
Time Base Generator

This circuit is a dividing ripple counter that provides 0.1 seconds pulses as well as a BCD count. The circuit consists of a divide-by-10 ripple counter and a divide-by 5 or divide-by 6 counter. An internal monostable is also included in the package.


BLOCK DIAGRAM
1
C_A
15
C_B
2
Reset
11
÷ 5/6 Control
7
B
9
A
$Q0_A$
3
$Q1_A$
4
$Q2_A$
5
$Q3_A$
6
$Q0_B$
12
$Q1_B$
13
$Q2_B$
14
Q_m
10
V_{DD} = Pin 16
V_{SS} = Pin 8


EXPANDED BLOCK DIAGRAM
C_A ÷ 10
Pulse Shaper
C
R
$Q0_A$
$Q1_A$
$Q2_A$
$Q3_A$
BCD Out
Reset
÷ 5/6 Control
C_B ÷ 5/6
Pulse Shaper
C
R
$Q0_B$
$Q1_B$
$Q2_B$
BCD Out
B
A
Mono stable Multi vibrator
Q_m

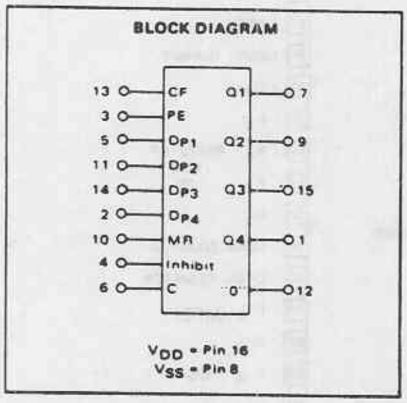
TIMING DIAGRAM


Divide-By-10 Counter
0 1 2 3 4 5 6 7 8 9 0 1
Clock
Reset
Q0
Q1
Q2
Q3
Divide-By 5/6 Counter
0 1 2 3 4 5 0 1 2 3 4 0
Clock
Reset
Control ÷ 5/6
Q0
Q1
Q2
Monostable Multivibrator
A
B
Q_m

▨ = Don't Care

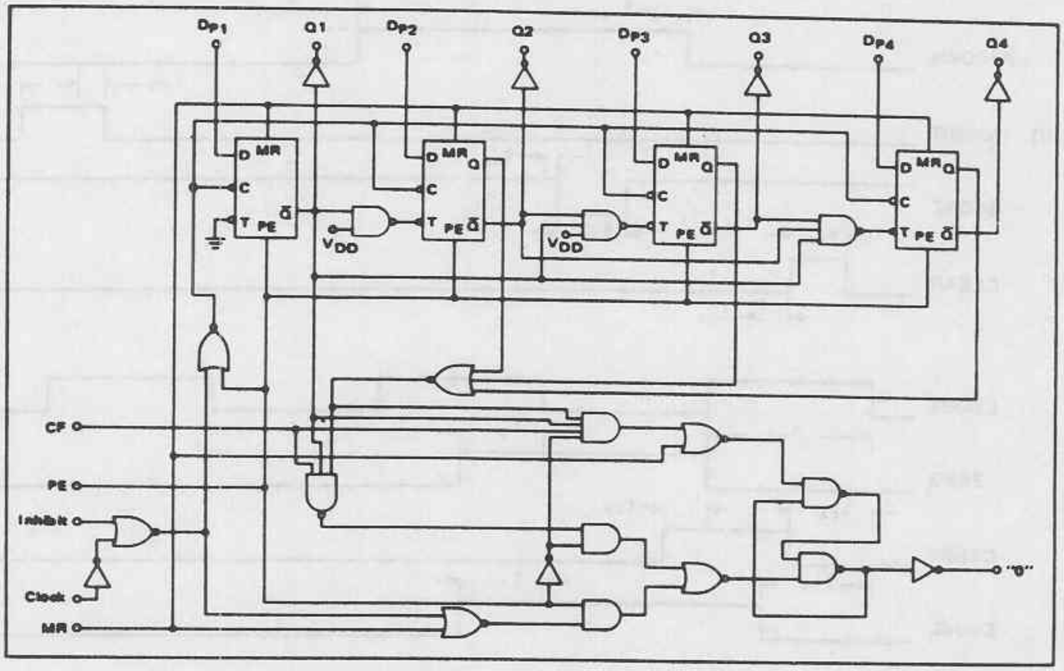
Programmable Divide-by-N Counter

This counter is a down-counter that provides a low or "O" output when the programmed BCD number is reached. Pulse counting can be disabled through the inhibit input.


BLOCK DIAGRAM
13 CF
3 PE
5 DP1
11 DP2
14 DP3
2 DP4
10 MR
4 Inhibit
6 C
Q1 7
Q2 9
Q3 15
Q4 1
"0" 12
V_{DD} = Pin 16
V_{SS} = Pin 8

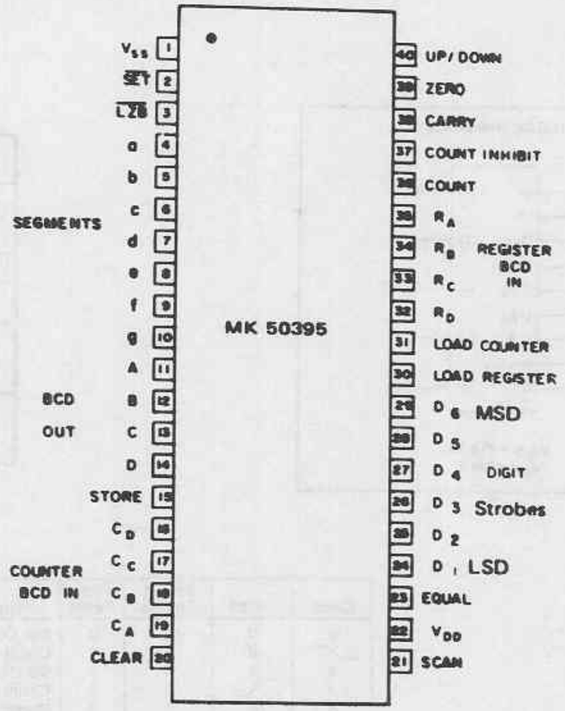
Count	Output			
	Q4	Q3	Q2	Q1
15	1	1	1	1
14	1	1	1	0
13	1	1	0	1
12	1	1	0	0
11	1	0	1	1
10	1	0	1	0
9	1	0	0	1
8	1	0	0	0
7	0	1	1	1
6	0	1	1	0
5	0	1	0	1
4	0	1	0	0
3	0	0	1	1
2	0	0	1	0
1	0	0	0	1
0	0	0	0	0

Clock	Inhibit	Preset Enable	Master Reset	Action
0	0	0	0	No. Count
↑	0	0	0	Count-1
X	1	0	0	No Count
1	↓	0	0	Count-1
X	X	1	0	Preset
X	X	X	1	Reset

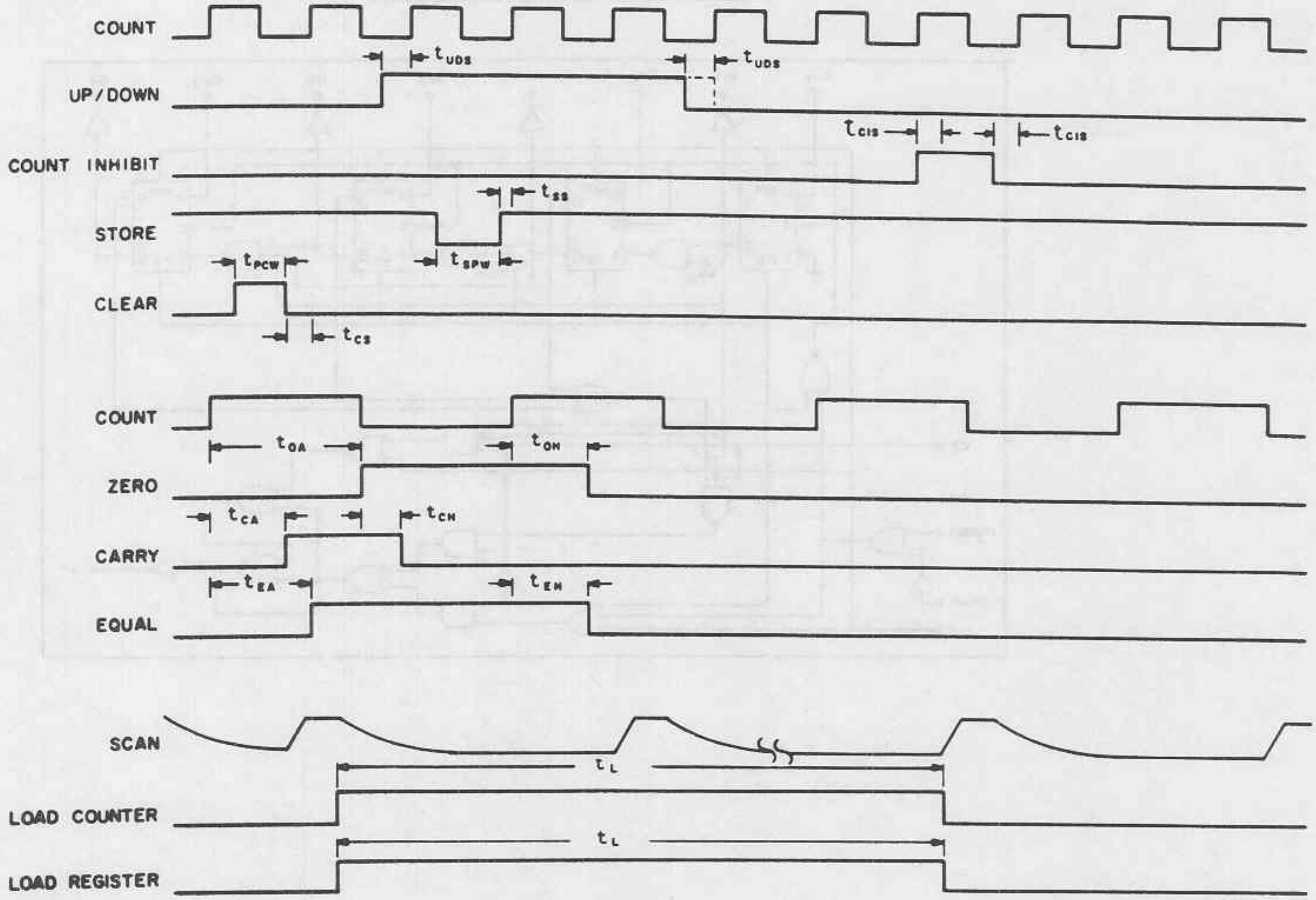

DP1
Q1
DP2
Q2
DP3
Q3
DP4
Q4
D
MR
C
T
PE
Q
Q̄
VDD
VDD
CF
PE
Inhibit
Clock
MR
"0"

Counter and Display Decoder

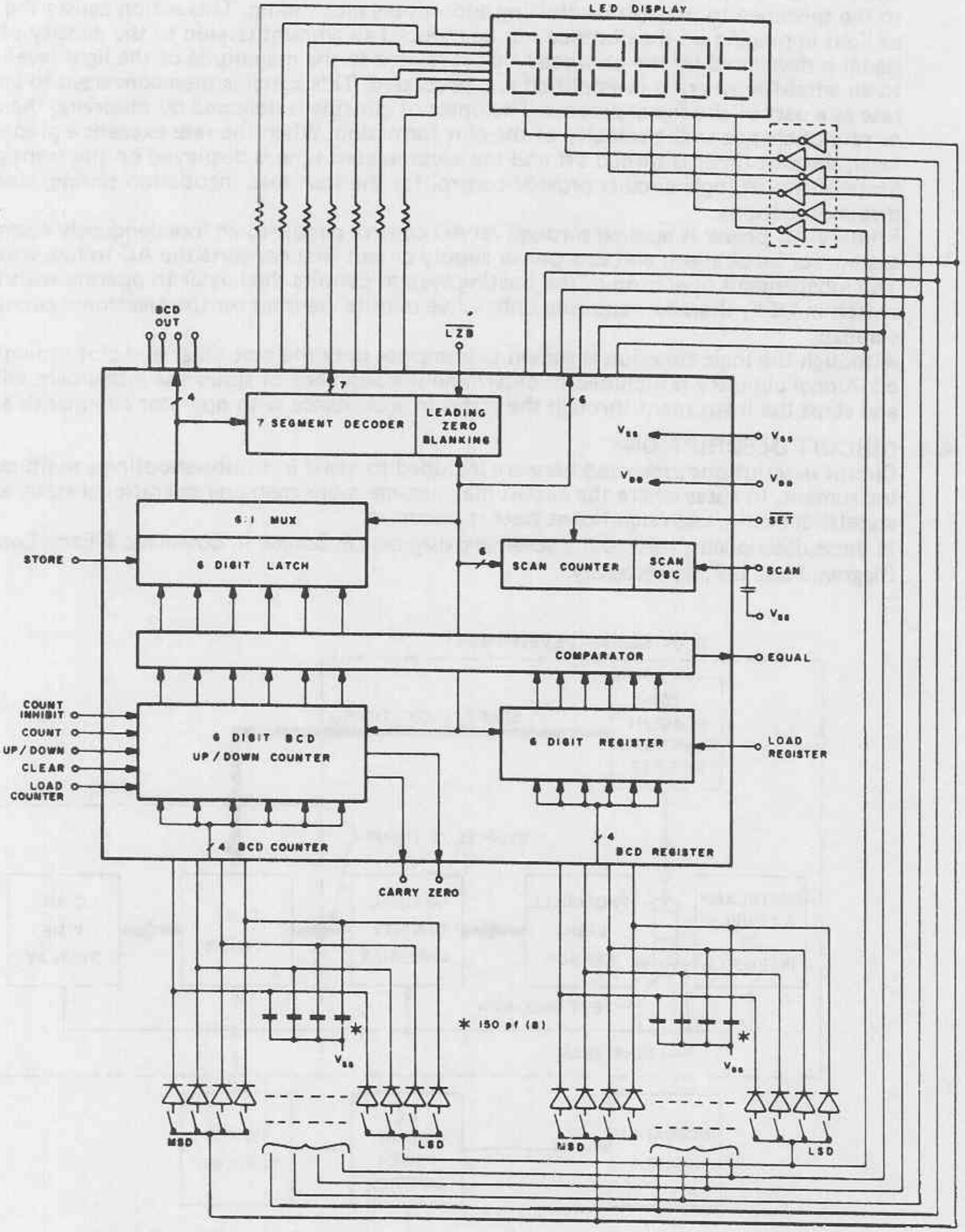
The counter and display decoder is a six-decade synchronous up/down-counter display driver with compare-register and storage latches. Scanning is controlled by an external scan oscillator even though an internal oscillator is available. This IC provides the timing and segment display logic for the E750.


MK 50395
VSS 1
SET 2
LZB 3
SEGMENTS
a 4
b 5
c 6
d 7
e 8
f 9
g 10
BCD OUT
A 11
B 12
C 13
D 14
STORE 15
COUNTER BCD IN
CD 16
CC 17
CB 18
CA 19
CLEAR 20
40 UP/DOWN
39 ZERO
38 CARRY
37 COUNT INHIBIT
36 COUNT
REGISTER BCD IN
35 RA
34 RB
33 RC
32 RD
31 LOAD COUNTER
30 LOAD REGISTER
DIGIT Strobes
29 D6 MSD
28 D5
27 D4
26 D3
25 D2
24 D1 LSD
23 EQUAL
22 VDD
21 SCAN

TIMING


COUNT
UP/DOWN
tUDS
tUDS
COUNT INHIBIT
tCIS
tCIS
STORE
tSS
tSPW
CLEAR
tPCW
tCS
COUNT
tOA
tOH
ZERO
tCA
tCH
CARRY
tEA
tEH
EQUAL
SCAN
tL
LOAD COUNTER
tL
LOAD REGISTER

FUNCTIONAL DIAGRAM


LED DISPLAY
BCD OUT
$\overline{LZB}$
4
7
6
7 SEGMENT DECODER
LEADING ZERO BLANKING
V_{SS}
V_{DD}
$\overline{SET}$
6:1 MUX
6 DIGIT LATCH
STORE
6
SCAN COUNTER
SCAN OSC
SCAN
V_{SS}
COMPARATOR
EQUAL
COUNT INHIBIT
COUNT
UP / DOWN
CLEAR
LOAD COUNTER
6 DIGIT BCD UP / DOWN COUNTER
6 DIGIT REGISTER
LOAD REGISTER
4 BCD COUNTER
4 BCD REGISTER
CARRY
ZERO
✱ 150 pf (8)
V_{SS}
MSD
LSD

6.3 OVERALL FUNCTIONAL THEORY OF OPERATION

The E750 utilizes an optical density change characteristic of plasma to determine when clotting takes place. Five major functional circuits are subdivided to provide seven major functions that provide an accurate measurement of clot time on a consistent basis.

The 750 system is comprised of a photolamp and photocell combination, an amplifier, a clot timer, a display, an AC control circuit, a heater system, and a power supply system. The 750 system operates, utilizing these functions as follows. A test sample, heated to 37°C is placed in a test station that is located in the light path between a photolamp and photocell. A reagent is added to the specimen to precipitate clotting and initiate clot timing. This action causes the intensity of light impinging on the photocell to be reduced an amount related to the density of the clot. A signal is developed by the photocell that is related to the magnitude of the light level and is passed to an amplifier where it is amplified and processed. This signal is then converted to an acceleration rate as a part of the signal process. The onset of clotting is detected by observing the acceleration or rate of change in the velocity of the clot formation. When the rate exceeds a predetermined level, the clot timer is turned off and the accumulated time is displayed on the front panel.

State-of-the-art logic circuits provide control for the start test, incubation timing, clot timing, and display functions.

Primary AC power is applied through an AC control circuit to an independently operated heater system for incubation, and to a power supply circuit that converts the AC to low voltage DC.

The independent operation of the heating system permits the heater to operate with the power switch in OFF, thereby, requiring only a five minute warmup for the electronic circuits to stablize.

Although the logic function is shown to comprise only the clot timer and clot time display, additional circuitry is included to determine the sequence of states the instrument will assume and steps the instrument through the states in accordance with operator commands and test results.

6.4 CIRCUIT DESCRIPTIONS

Circuit descriptions presented here are included to assist in troubleshooting a malfunctioning instrument. In cases where the circuit may assume more than one operational state, and the other state(s) are valid, each significant state is discussed.

In these descriptions, refer to the schematic diagrams in Section II, Schematic & Parts Location Diagram/Parts List, as necessary.

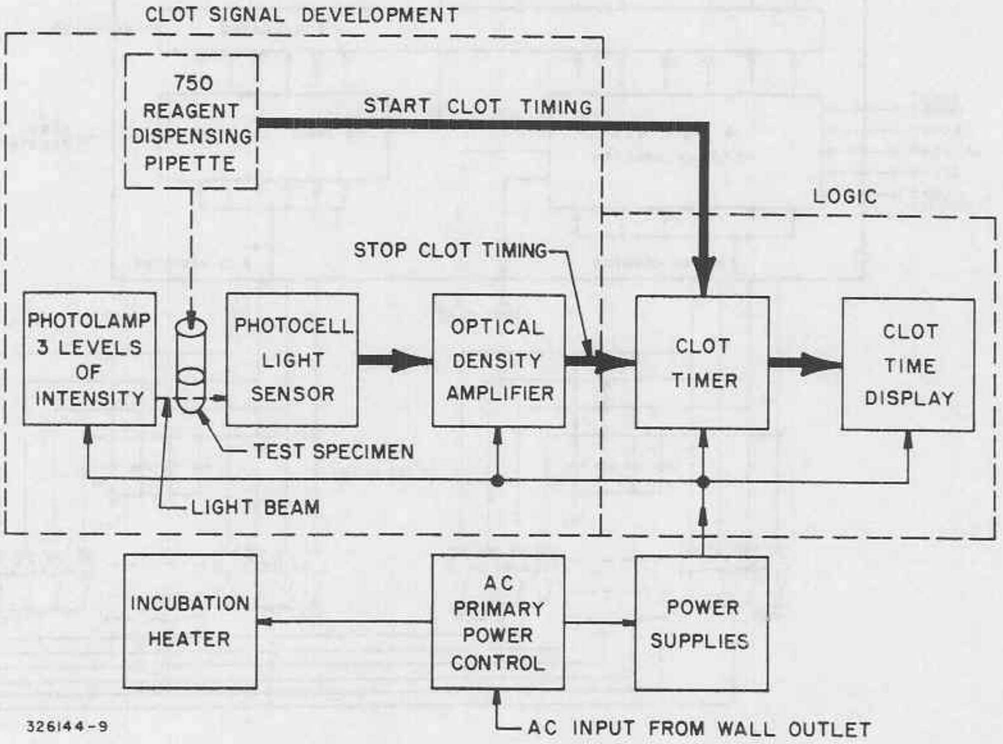

CLOT SIGNAL DEVELOPMENT
750 REAGENT DISPENSING PIPETTE
START CLOT TIMING
LOGIC
STOP CLOT TIMING
PHOTOLAMP 3 LEVELS OF INTENSITY
PHOTOCELL LIGHT SENSOR
OPTICAL DENSITY AMPLIFIER
CLOT TIMER
CLOT TIME DISPLAY
TEST SPECIMEN
LIGHT BEAM
INCUBATION HEATER
AC PRIMARY POWER CONTROL
POWER SUPPLIES
AC INPUT FROM WALL OUTLET
326144-9

Figure 6-1. Overall Functional Block Diagram

6.4.1 Heater System

The entire work area of the Electra 750 is made from a block of aluminum that is heated to 37.2° C± 0.2° C (98° F). This insures that the reagents, samples, and pipette tips are warmed for an optimum reaction temperature.

The heating block is warmed by a cartridge heating element mounted on the underside of the block. The temperature is sensed by a thermistor also mounted on the heater block and the temperature is regulated by an electronic circuit located on the AC Power/Heater P/C board, A2A1. When the heater block is within± 0.3C of its set temperature, the "AT TEMP" indicator lamp on the front panel lights.

Heating Circuit —The heating circuit is shown in Figure 6-2, including the current path for the heating element and controlled switching device.

The circuit operates independently of front panel ON - OFF switch S3, such that the heating system is operative as long as primary power is applied and interlock switch S1 is closed. This primary input power is applied at power connector P9 on the rear panel. One side of the line is coupled through thermal fuse A2F1, to the heating element; the return is coupled from the heating element through a Triac (solid state ac switching device), back to the line. The thermal fuse, A2F1, prevents excessive temperatures by opening the heating circuit when temperature of 55^{O} C is exceeded. This could only occur by a catastrophic failure of the heating control circuit.

WARNING

When ambient or storage temperature exceeds 55^{O} C (131^{O} F), the thermal fuse may open and interrupt current flow. When there is no heating and this condition has existed, investigate the possibility of an open fuse.

Heater Control Circuit—(See Figure 6-3) Current is supplied to the heater when thermistor R1 senses a decrease in the block temperature, which causes the thermistor's resistance to increase. This resistance change unbalances the bridge circuit and presents a positive input voltage (voltage at positive input greater than negative input) to comparitor U1C. Simultaneously, U1D is enabled by the zero crossover detector each time the A.C. power cycle passes through zero. When a positive input is applied to U1C and U1D is enabled by the zero crossing network, transistor Q1 is turned on. This turns on triac Q2, (the triac is a solid state ac switch.) When triac Q2 turns on, power is applied to the heater. The zero-cross network insures that triac Q2 turns on when the applied ac voltage is near zero, which minimizes RF1 output.

When triac Q2 is on and power is applied to the heater, the voltage from TP3 to ground is less than 10VAC. When triac Q2 is off, the voltage on TP3 is 115VAC.

At Temperature Indicator Circuit—The indicator circuit (Figure 6-4) controls the excitation of the AT TEMP Lamp. When the thermistor indicates the temperature is within± 0.3^{O} C of the set temperature, the AT TEMP lamp lights. The balanced bridge used for the heater control circuit is also used for the at-temperature indicator. When the thermistor indicates the temperature is outside limits established by the value of the bridge resistors, a positive voltage output is applied to A1A2Q3 biasing it to conduct through opto-isolator U2. This action applies a logic high (+12VDC) to the At-Temp signal line. This signal is inverted by inverter U2E on logic control assembly A1A4 then lights AT TEMP lamp DS2 on display assembly A2A2.

6.4.2 Power Control Circuit (Figure 6-5)

Primary power is controlled by a front panel ON-OFF switch which in turn, controls a relay that applies ac to the various power supplies, except the heater circuit, which has primary power applied independent of the ON-OFF switch. All power, including the heater is switched by a cover interlock switch.

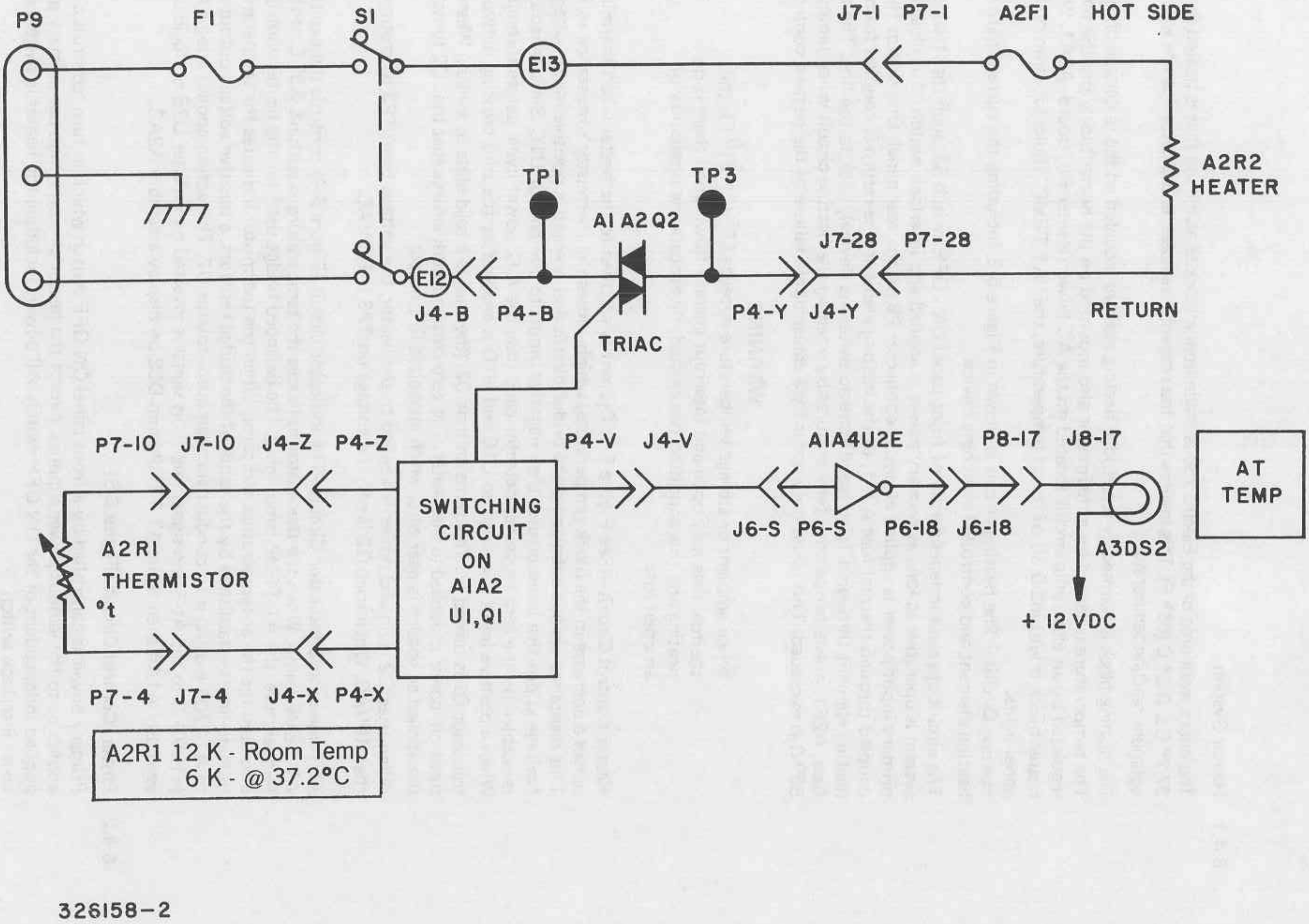
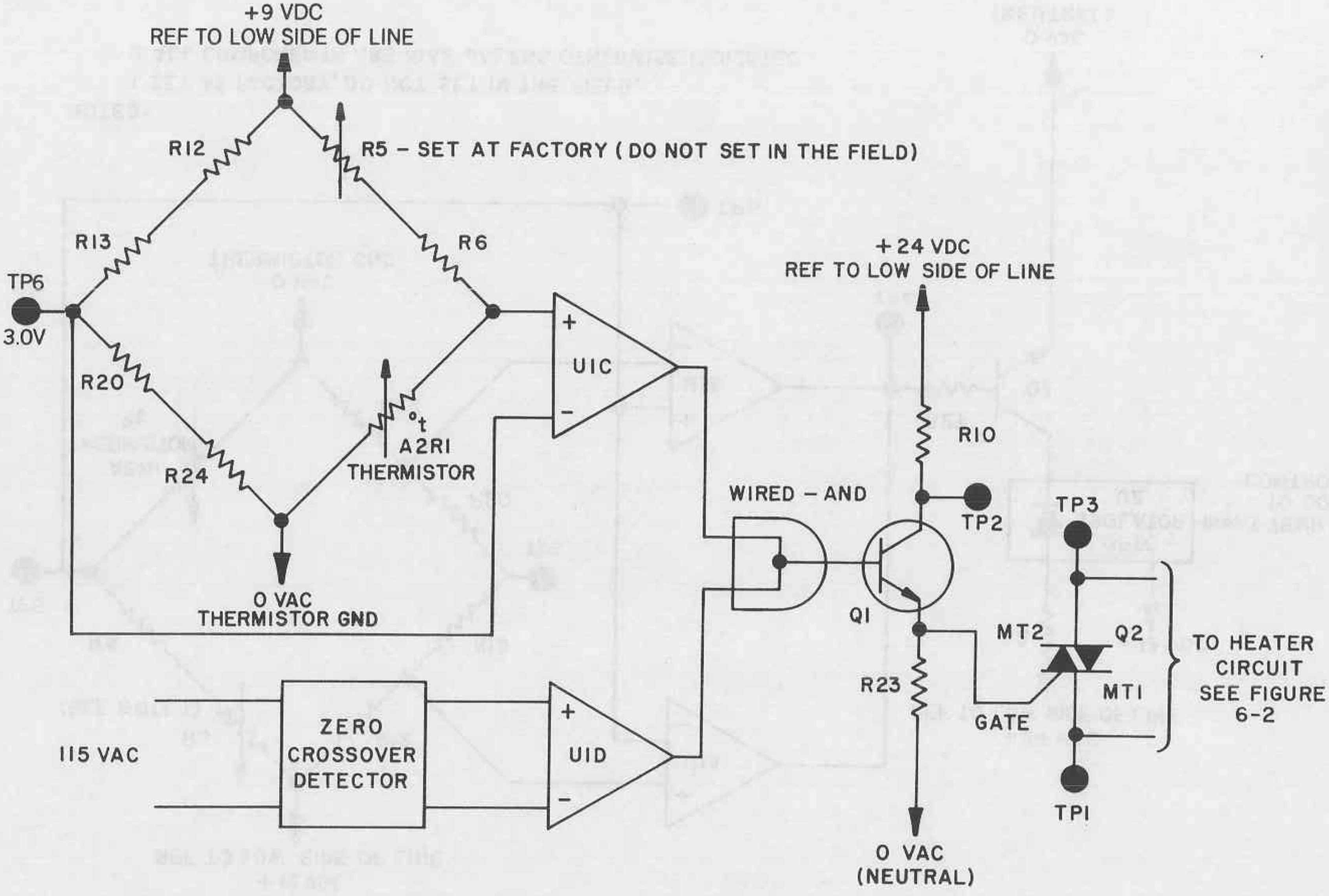

P9
F1
S1
E13
J7-1
P7-1
A2F1
HOT SIDE
A2R2
HEATER
TP1
TP3
A1 A2 Q2
J7-28
P7-28
E12
J4-B
P4-B
TRIAC
P4-Y
J4-Y
RETURN
P7-10
J7-10
J4-Z
P4-Z
SWITCHING
CIRCUIT
ON
A1A2
U1,Q1
P4-V
J4-V
A1A4U2E
P8-17
J8-17
AT
TEMP
J6-S
P6-S
P6-18
J6-18
A3DS2
A2R1
THERMISTOR
°t
+ 12 VDC
P7-4
J7-4
J4-X
P4-X
A2R1 12 K - Room Temp
6 K - @ 37.2°C
326158-2

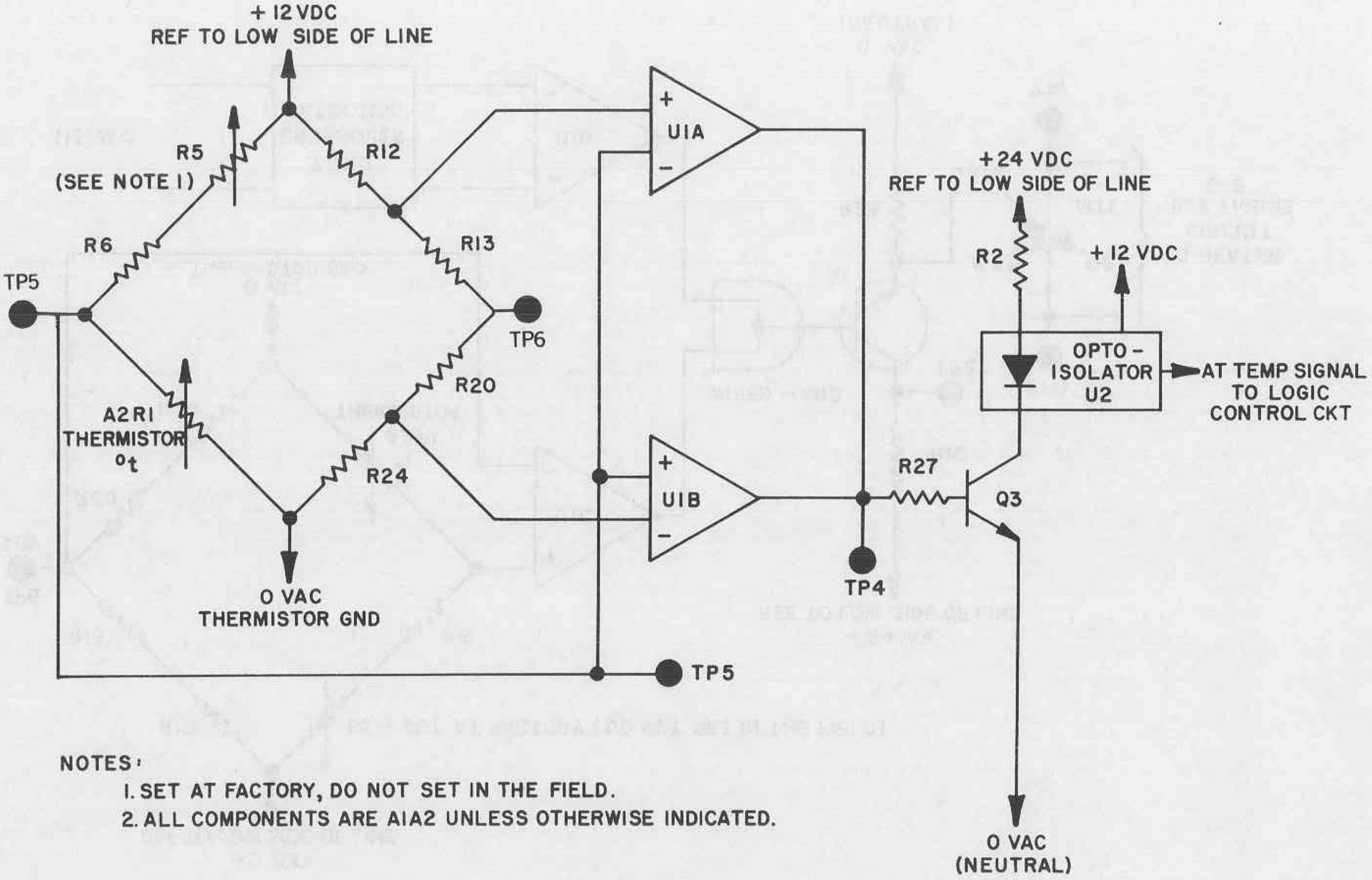
Figure 6-2. Heater Circuit Simplified Schematic Diagram


+9 VDC
REF TO LOW SIDE OF LINE
R12
R5 - SET AT FACTORY (DO NOT SET IN THE FIELD)
R13
R6
TP6
3.0V
+
UIC
−
R20
°t
A2RI
THERMISTOR
R24
0 VAC
THERMISTOR GND
+24 VDC
REF TO LOW SIDE OF LINE
R10
WIRED - AND
TP2
TP3
Q1
MT2
Q2
TO HEATER
CIRCUIT
SEE FIGURE
6-2
R23
MT1
GATE
115 VAC
ZERO
CROSSOVER
DETECTOR
+
UID
−
TP1
0 VAC
(NEUTRAL)

NOTE: ALL COMPONENTS ARE A1A2 UNLESS OTHERWISE INDICATED.

326158-7

Figure 6-3. Heater Control Circuit Simplified Schematic Diagram


+ 12 VDC
REF TO LOW SIDE OF LINE
R5
(SEE NOTE 1)
R12
R6
R13
TP5
TP6
A2 R1
THERMISTOR
°t
R20
R24
0 VAC
THERMISTOR GND
TP5
+
U1A
−
+
U1B
−
TP4
R27
Q3
+24 VDC
REF TO LOW SIDE OF LINE
R2
+ 12 VDC
OPTO-
ISOLATOR
U2
AT TEMP SIGNAL
TO LOGIC
CONTROL CKT
0 VAC
(NEUTRAL)

NOTES:

1. SET AT FACTORY, DO NOT SET IN THE FIELD.
2. ALL COMPONENTS ARE A1A2 UNLESS OTHERWISE INDICATED.

326158-8

Figure 6-4. AT Temperature Indicator Circuit Simplified Schematic

Power is applied through connector P9 on the rear panel and coupled through rear panel mounted fuse F1, shorting bar S2 and developed across the appropriate primary winding, depending on the input voltage. This primary power is tapped at the 115-volt point and applied to the heater circuit and the ON-OFF switch. There is also a 105-volt tap used for the stirrer motor. An 18-volt primary tap is used for developing +24VDC and $12VDC which are both referenced to the low side of the ac line. When ON-OFF switch A3S1 is operated to the ON position, 115 volts is applied through S1A to power control relay A1A2K1, energizing it and connecting the secondary voltages to their respective circuits. In addition, stirrer motor A3M1 is activated through the other half of ON-OFF switch S1B.

6.4.3 Power Supply

Power supply assembly A1A1 contains three of the power supplies required for the E750 circuits. These are± 12 volts dc and the adjustable lamp supply. The circuits employed are standard power supply circuits with bridge rectifiers and regulating integrated circuits. Controls are provided for voltage adjustments. Lamp level switch S3 connects programming resistors to provide three lamp level voltages at pin 1 of J3/P3. Resistors for developing these voltages are shown in figure 6-5 between terminals E2 and E3. Switch S3 is a three-position ON-OFF toggle switch that either connects resistors R1, R2 and R3 in the circuit to provide the "A" lamp level; resistors R1 and R2 for the "B" lamp level; R2 for the "C" lamp level. In figure 6-5, switch S3 is shown in the "C" lamp level position together with a connecting table for the switch positions. Adjustments to the voltage levels must be made in the following sequence: +12V, -12V, +2.75V, and +5.25, when necessary. (See Section 10).

6.4.4 Logic Circuits

The logic circuits in the E750 control are logic functions that are necessary to measure plasma clotting time. The functions include establishing the operational state, sequencing of the instrument through each of the operational states, as well as controlling the timing and display functions. The following circuit description is presented in steps, starting with the overall circuit functional description, followed by a description of each major function.

The primary purpose of the logic circuit is to program all of the activities and functions of the instrument. Fig. 6-6 shows the major functional blocks of the logic circuit. With the exception of the amplifier, all the circuitry corresponding to the logic functions is contained on logic control board A1A4.

A three-bit State Counter is the control center for the logic circuits. It's state determines the instrument state.

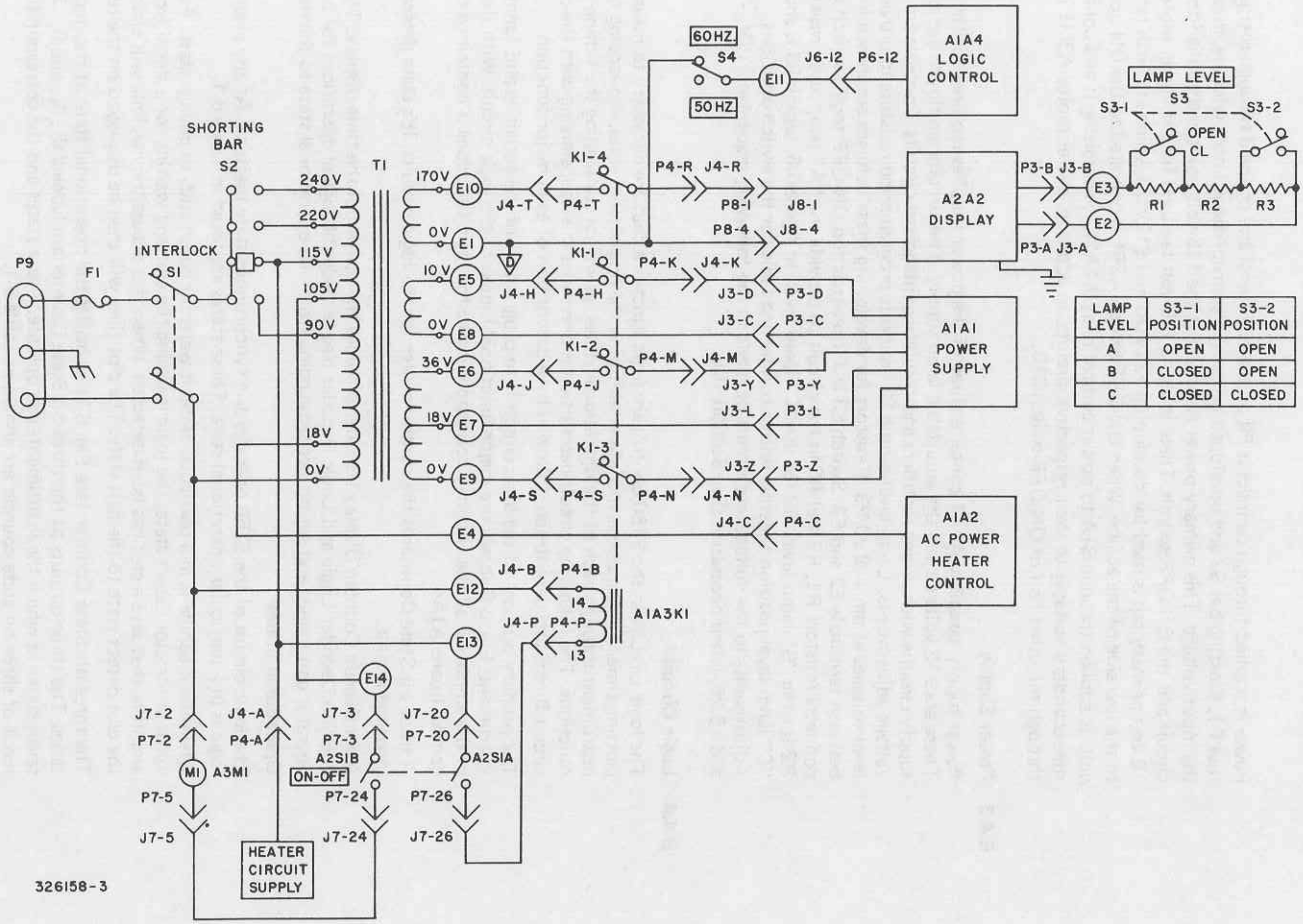
A six Decade Counter/Display Decoder provides the control of the time display. The Switch Position Decoder Logic and Logic Decoder tree provide the logical operations for processing operator commands and for proper sequencing from one operational state to the next.

Operational States

The logic circuit of the E750 operates as a synchronous state machine. At any given time, the logic is in a particular operational state. These states are listed in Table 6-1.

When the machine is in a particular state, it waits for commands to change state. For example, when in the clot detect state, the logic is timing the clot and waiting for a signal from the amplifier that says a clot has been detected. When this occurs the machine will change from the clot detect state to the halt state. The clot time will then be displayed on the readout.

The three-bit State Counter (see Fig. 6-7) identifies the operational state of the machine at all times. The three outputs of the three-bit State Counter are labeled $\emptyset_2$, $\emptyset_1$, and $\emptyset_o$. There are seven states in which the instruments can operate. These states and the corresponding logic levels of three-bit state counter are shown in Table 6-1.


A1A4
LOGIC
CONTROL
60HZ
S4
50HZ
E11
J6-12
P6-12
LAMP LEVEL
S3
S3-1
S3-2
OPEN
CL
A2A2
DISPLAY
P3-B
J3-B
E3
R1
R2
R3
E2
P3-A
J3-A
P4-R
J4-R
P8-1
J8-1
P8-4
J8-4
K1-4
K1-1
K1-2
K1-3
P4-K
J4-K
J3-D
P3-D
J3-C
P3-C
P4-M
J4-M
J3-Y
P3-Y
J3-L
P3-L
J3-Z
P3-Z
P4-N
J4-N
J4-C
P4-C
A1A1
POWER
SUPPLY
A1A2
AC POWER
HEATER
CONTROL
SHORTING
BAR
S2
T1
240V
220V
115V
105V
90V
18V
0V
170V
10V
36V
E10
E1
E5
E8
E6
E7
E9
E4
E12
E13
E14
J4-T
P4-T
J4-H
P4-H
J4-J
P4-J
J4-S
P4-S
J4-B
P4-B
J4-P
P4-P
14
13
A1A3K1
INTERLOCK
S1
P9
F1
J7-2
P7-2
M1
A3M1
P7-5
J7-5
J4-A
P4-A
HEATER
CIRCUIT
SUPPLY
J7-3
P7-3
A2S1B
ON-OFF
P7-24
J7-24
J7-20
P7-20
A2S1A
P7-26
J7-26
326158-3

LAMP LEVEL	S3-1 POSITION	S3-2 POSITION
A	OPEN	OPEN
B	CLOSED	OPEN
C	CLOSED	CLOSED

Figure 6-5. Power Control Simplified Schematic Diagram

Table 6-1. OPERATIONAL STATES

State	State Counter $\emptyset_2$	$\emptyset_1$	$\emptyset_o$
Hold	0	0	1
Halt	0	1	1
Clot Detect	1	1	1
Incubation Timing	1	1	0
Guard Interval	1	0	0
Guard B	1	0	1
Reset	0	X	0

Note: X denotes a "don't care" - either 0 or 1. In Fig. 6-7 a state diagram shows all the operational states and indicates the logical signals that will effect a change of state.

When the instrument is turned on by operating the ON/OFF switch to the ON position, the E750, through it's power reset circuitry, comes on in the reset state. As shown in the state diagram, Figure 6-7, there are only two paths out of this state. When the incubation timer switch is depressed and there is no tube in the test station ($IT \cdot \overline{T} = 1$) the instrument goes into the incubation timing state.

When the incubation timing switch is depressed a second time or a tube is placed in the test station ($I\overline{T} + T = 1$), the instrument returns to the reset state. The second way out of the reset state is by placing a tube in the test station and depressing the time start switch ($S \cdot T = 1$): The instrument then goes into the guard interval timing state. Upon completion of the guard interval ($EQ = 1$), the instrument moves into the guard B state, where the logic circuit monitors the output of the amplifier for a clot signal. A clot signal present at the completion of the guard clock interval ($\overline{C} = O$) causes the instrument to remain in the guard B state until the clot signal is removed from the amplifier's output. However, if at the completion of the guard interval, there is no clot signal ($C = 1$), the instrument goes into the clot detect state. The instrument now monitors two amplifier signals. As the optical density of the plasma test sample exceeds the limits of a predetermined range ($OS = 1$), the off-scale lamp lights, and the instrument goes to the reset state. Simultaneously, the instrument monitors the amplifier output for a clotting signal ($C = 1$). When a clot signal appears on the output of the amplifier, the clot verifier timer is enabled. This timer insures that the clot signal persists for 0.5 second. At the end of the 0.5 second period the instrument adds an appropriate time delay, depending on its mode of operation and moves into the halt state. The halt state stops the clot timing circuitry and displays the clot time on the display. When the tube is removed from the test station ($T = 0$), the instrument goes into the hold state, where the clot time remains on the display. The instrument remains in the hold state until either a tube is placed in the test station or the incubation timer switch is depressed ($T + IT = 1$). Then, it returns to reset. In the guard interval state, the guard B state, and the clot detect state, the instrument requires that the tube remain in the test station. If at any time during these three states the tube is removed ($T = 0$), the instrument will immediately return to the reset state. The state of the instrument as determined by the output of the three-bit state counter can be observed on the three test points designated $\emptyset_0$, $\emptyset_1$, O_2.

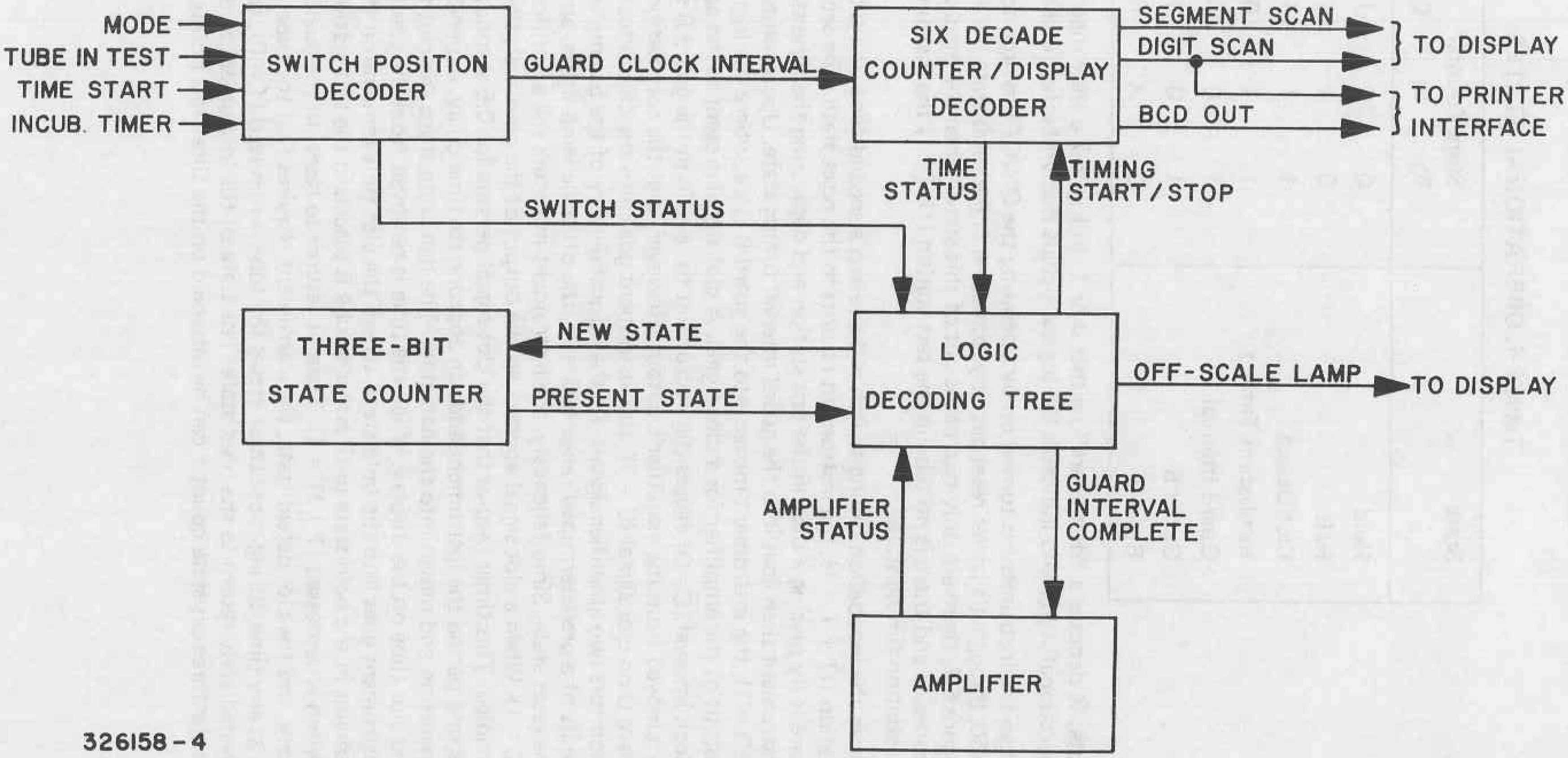
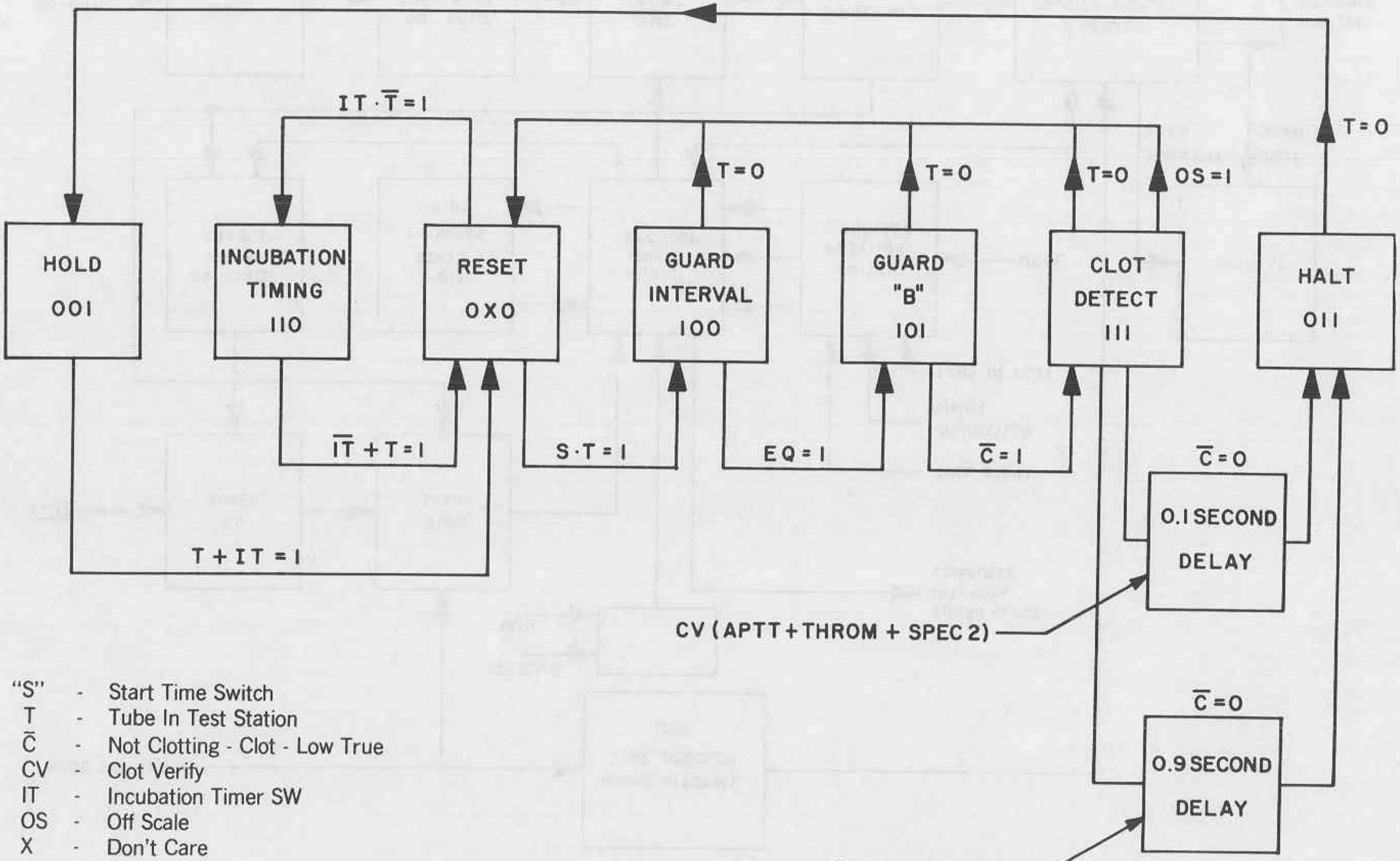

MODE
TUBE IN TEST
TIME START
INCUB. TIMER
SWITCH POSITION DECODER
GUARD CLOCK INTERVAL
SIX DECADE COUNTER / DISPLAY DECODER
SEGMENT SCAN
DIGIT SCAN
BCD OUT
TO DISPLAY
TO PRINTER INTERFACE
TIME STATUS
TIMING START/STOP
SWITCH STATUS
THREE-BIT STATE COUNTER
NEW STATE
PRESENT STATE
LOGIC DECODING TREE
OFF-SCALE LAMP
TO DISPLAY
AMPLIFIER STATUS
GUARD INTERVAL COMPLETE
AMPLIFIER
326158-4

Figure 6-6. Logic Functional Block Diagram


HOLD
001
INCUBATION
TIMING
110
RESET
0X0
GUARD
INTERVAL
100
GUARD
"B"
101
CLOT
DETECT
111
HALT
011
$IT \cdot \overline{T} = 1$
$\overline{IT} + T = 1$
$S \cdot T = 1$
$EQ = 1$
$\overline{C} = 1$
$T + IT = 1$
T = 0
T = 0
T = 0
OS = 1
T = 0
$\overline{C} = 0$
0.1 SECOND
DELAY
$\overline{C} = 0$
0.9 SECOND
DELAY
CV (APTT + THROM + SPEC 2)
CV (PT + SPEC 1)

"S" - Start Time Switch
T - Tube In Test Station
$\overline{C}$ - Not Clotting - Clot - Low True
CV - Clot Verify
IT - Incubation Timer SW
OS - Off Scale
X - Don't Care
• - And
+ - Or

Figure 6-7. Logic State Diagram

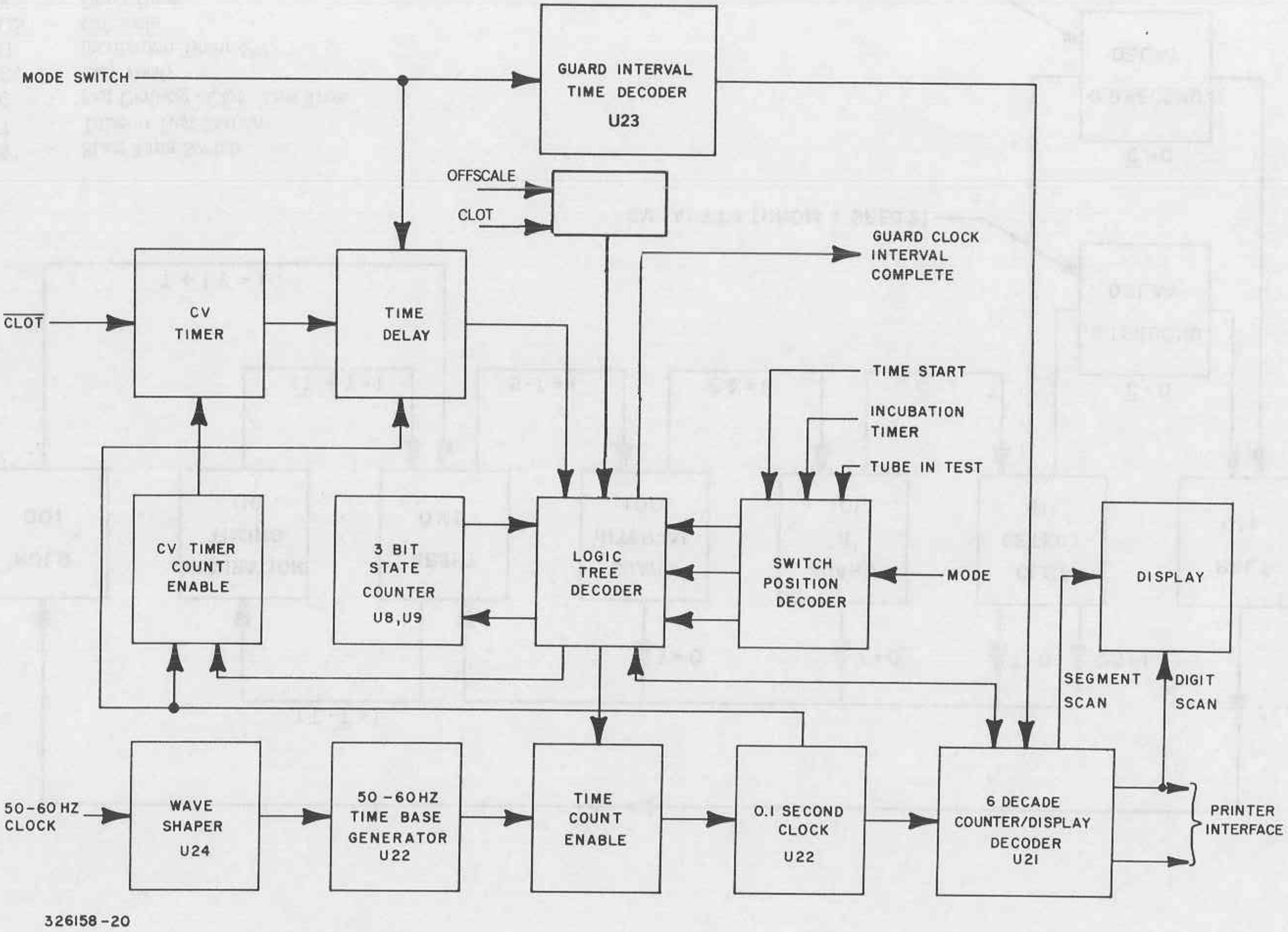

MODE SWITCH
GUARD INTERVAL TIME DECODER U23
OFFSCALE
CLOT
GUARD CLOCK INTERVAL COMPLETE
CLOT
CV TIMER
TIME DELAY
TIME START
INCUBATION TIMER
TUBE IN TEST
CV TIMER COUNT ENABLE
3 BIT STATE COUNTER U8,U9
LOGIC TREE DECODER
SWITCH POSITION DECODER
MODE
DISPLAY
SEGMENT SCAN
DIGIT SCAN
50-60 HZ CLOCK
WAVE SHAPER U24
50-60HZ TIME BASE GENERATOR U22
TIME COUNT ENABLE
0.1 SECOND CLOCK U22
6 DECADE COUNTER/DISPLAY DECODER U21
PRINTER INTERFACE
326158-20

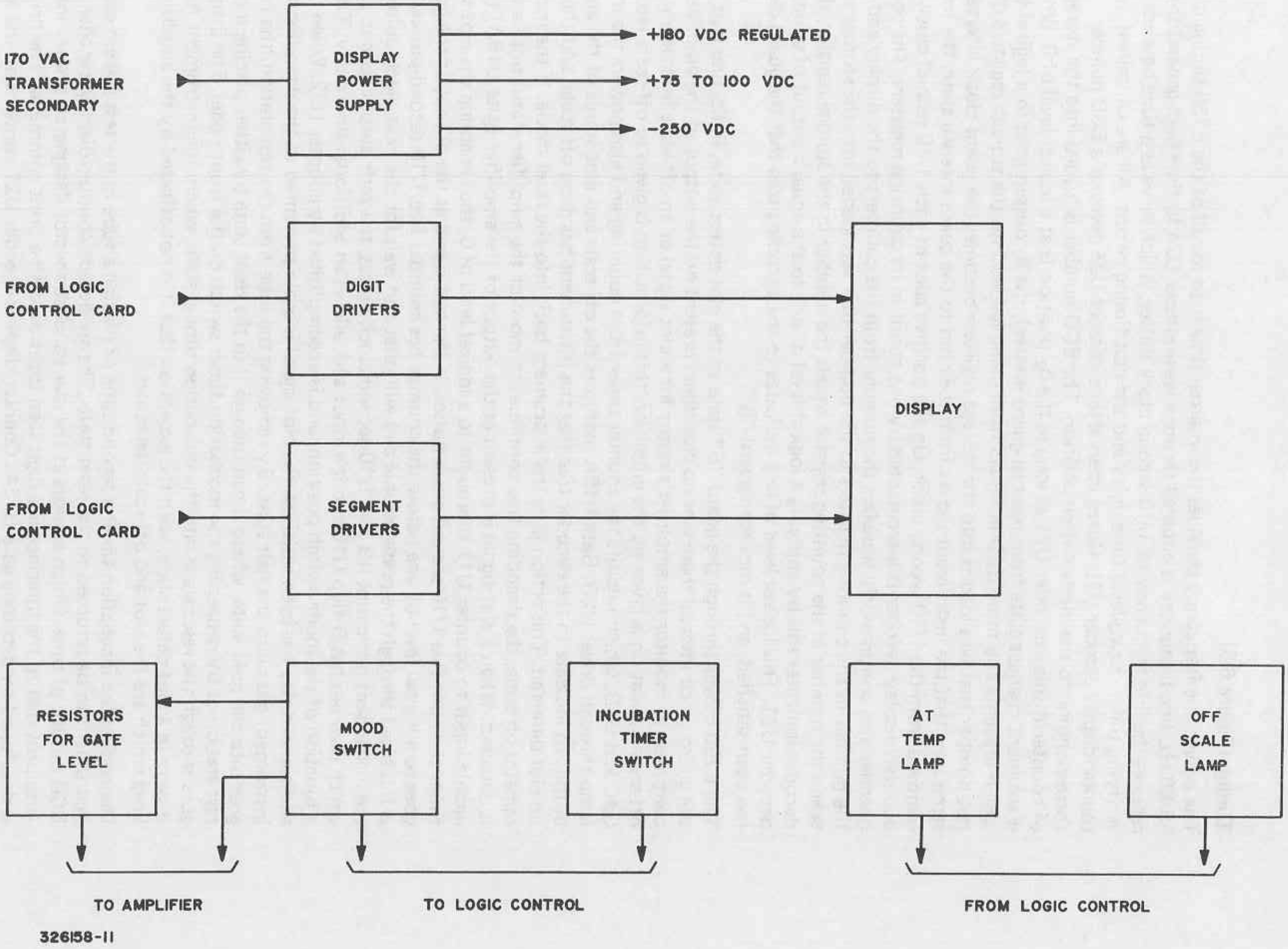
Figure 6-8. Timing Functional Block Diagram

Timing (Figure 6-8)

The power line frequency provides the internal time base for all of the E750 timing circuits. The 50/60 Hz. line frequency is coupled through wave shaper U24 to time base generator U22 that reduces the line frequency to 1/10 second clock pulses, which serve as a time base for a clot verifying timer, a two-level time delay and the clot timing circuit. All are contained in six decade counter/display decoder U21. Guard interval time decoder U23 develops a BCD number corresponding to the mode switch position. The BCD number is loaded into the storage registers of counter/display decoder U21 as long as the $\emptyset_2$ position is at a logical level of 0. When the instrument changes state from reset to guard interval, the $\emptyset_2$ output goes to a logical level of 1, which prevents any more BCD numbers from being loaded into the storage registers of U21. The last number that was loaded into the storage registers becomes the guard clock interval. At the same time that the instrument moves from the reset to the guard interval state, the inhibit is removed from the 1/10 second clock. On the positive edge of each 1/10 second clock pulses, the counter/display decoder is incremented by one count in its counting registers. The counter/display decoder also continuously transfers the number from the counters to the display and compares the number in the counting registers to the number that was loaded into the storage registers. When the number in the counting register equals the number in the storage register, the counter/decoder indicates this by applying a logical level of one to the equal's output of counter/display decoder U21. This logical level of one indicates to the decoding tree that the guard clock interval has been satisfied, and it moves to guard "B".

The E750 moves through the guard "B" state to the clot detect state, indicating that at the end of the guard clock interval there was no clot signal present on the output of the amplifier. The logic continues to monitor the amplifier's status for a clot signal or an off-scale indication. If an off-scale indication is given by the amplifier, this information is given to off-scale latching flip-flop U4C and U4D, which inhibits the counter timer from counting and also powers the off-scale lamp through driver U2D. Gate U15A monitors the off-scale and clot status of the amplifier's output to indicate to the decoder tree that the instrument has gone off-scale, and there has been no clot detected. This action puts the instrument back into the reset mode. If the instrument remains on scale, the decoding tree continues to monitor the amplifier status until a clot signal is detected. When a clot signal is present at the output of the amplifier (gate U15A) the preset enable input to counter U17 is brought to a logical level of 0, thus enabling the clot verifier timer to count five 1/10 second clock pulses. If the clot signal at the output of the gate U15A goes to a logical level of one before the counter has counted five 1/10 second pulses, counter U17 is inhibited through the preset enable and will reset and wait for the next clock pulse. However, if the instrument can count it's five 1/10 second clock pulses, the zero output goes to a logical one, which now latches D-flop U16B to it's input and, allows an additional time delay. This delay is a function of the mode switch position, and is accomplished by counter U22. When this additional delay has been satisfied, the clot signal is again presented to the decoding tree, and the instrument goes into the halt state. By removing the tube from the test station, the instrument goes into the hold state, where it can then go into the reset state by either placing a tube in the test station or by depressing the incubation timer switch on the front panel. The instrument then goes through the reset state into the incubation timing state, where the instrument functions as if it were in a clot detect state, with the exception that it is not affected by the amplifier status lines which are the clot and off-scale detectors.

Depressing the incubation timer a second time or placing a tube in the test station causes the instrument to be returned to the reset state. The six-decade counter/display decoder provides a BCD output of time, which appears at the rear panel connector designated printer interface. Also provided to the interface is a digit scan together with a print command. The print command is developed by decoding gate U12A. Counter/display decoder U21 contains all the logic required to scan the gas discharge tube displays. The rate at which the displays are scanned is determined by the frequency of scan oscillator U24C and U24D. Also, the counter/display decoder contains a seven-segment decode of the BCD time as well as the digit scan, all of which are available at the printer interface.



170 VAC TRANSFORMER SECONDARY
DISPLAY POWER SUPPLY
+180 VDC REGULATED
+75 TO 100 VDC
-250 VDC
FROM LOGIC CONTROL CARD
DIGIT DRIVERS
FROM LOGIC CONTROL CARD
SEGMENT DRIVERS
DISPLAY
RESISTORS FOR GATE LEVEL
MOOD SWITCH
INCUBATION TIMER SWITCH
AT TEMP LAMP
OFF SCALE LAMP
TO AMPLIFIER
TO LOGIC CONTROL
FROM LOGIC CONTROL
326158-11

Figure 6.9. Display Functional Block Diagram

Display

The display assembly contains all of the power supplies, digit and segment drivers for the display tubes. Also contained on the Display Assembly is the Mode Selector Switch, the gate level resistors, incubation timer switch, OFF-SCALE, and AT-TEMP indicator lamps (see fig. 6-9).

The 170 VAC secondary at transformer T1 is converted at the display assembly into a 180 VDC regulated voltage source, which is applied to the anodes of each display tube by the resistor voltage divider. A +75 to 100 VDC voltage source is generated that biases each of the display tubes to the off state. The -250 VDC power supply is also generated from the 170 VAC and is used for the keep alive cathodes. (see fig. 6-10). There are two seven-segment gas discharge display tubes, each of which contains two digits. They display time in seconds and tenths of seconds, from 000.0 to 999.9 seconds.

All of the timing functions as well as all of the logic required to time division multiplex (scan) these display tubes are contained within the 6-decade counter/display decoder on logic assembly A1A4. The segments (cathodes) from each of the display tubes are wired to a common segment bus line, and are connected to a segment output of the 6-decade counter/display decoder. Each display tube anode is connected to the appropriate digit scan output of the 6-Decade Counter/Display Driver.

The 6-Decade Counter/Display Decoder places 7-segment information on to the segment bus line. Simultaneously, the appropriate digit scan is raised to a logic level of 1. Two transistors at each of the display tube anodes, serve as level transistors, that raise the +12 VDC logic level (digit scan output) to 180 VDC which is required to illuminate the display tube.

The time information is changed, and the next sequential digit scan is raised to a logical level of 1. This sequencing of information continues, starting with the Most Significant Digit (MSD) and continuing to the Least Significant Digit (LSD), always placing the correct segment information at the proper digit (see fig. 6-11). The rate at which this information is changed is determined by the frequency of scan oscillator U24 on the logic assembly.

6.4.5 CLOT DETECTION SYSTEM

A Pre-amp (A2A1) and an Amplifier (A1A3) are used by the E750 for clot detection. In the discussion, reference designation prefixes are omitted, unless item mentioned is located on an assembly other than the one under discussion.

The photcell is mounted on the pre-amp assembly and continually monitors the light being transmitted through the plasma sample. As the clot is formed, the amount of light being transmitted through the plasma decreases, causing the photocell to increase its resistance, producing an output signal from the Pre-amp directly related to the light level.

The pre-amp's output signal is coupled to the amplifier assembly where the second derivative of the pre-amp signal is taken. The resulting signal is then amplified and coupled to a comparitor. When the comparitor's requirements are satisfied, the amplifier sends a signal to the logic circuits indicating that a clot has formed.

Pre-Amplifier Assembly A2A1

The photocell that monitors the light transmitted through the plasma sample develops a resistance level based on the amount of light on its surface. An increase in the light level produces a decrease in the resistance of the photocell. Correspondingly, a decrease in the light produces an increase in the resistance. A precision voltage source, U1, and resistor R1 bias the photocell to convert its resistance changes to voltage level changes. Amplifier U2 utilizes photocell R4 as part of its feedback/gain determining network. The gain of Amplifier U2 is equal to the ratio of resistor R1 to the parallel combination of resistors R2, R4, and the photocell. This circuit causes the resulting output of amplifier U2 to be proportional to the resistance of the photocell. The output of the pre-amp can vary from 0.0 to –10 volts.

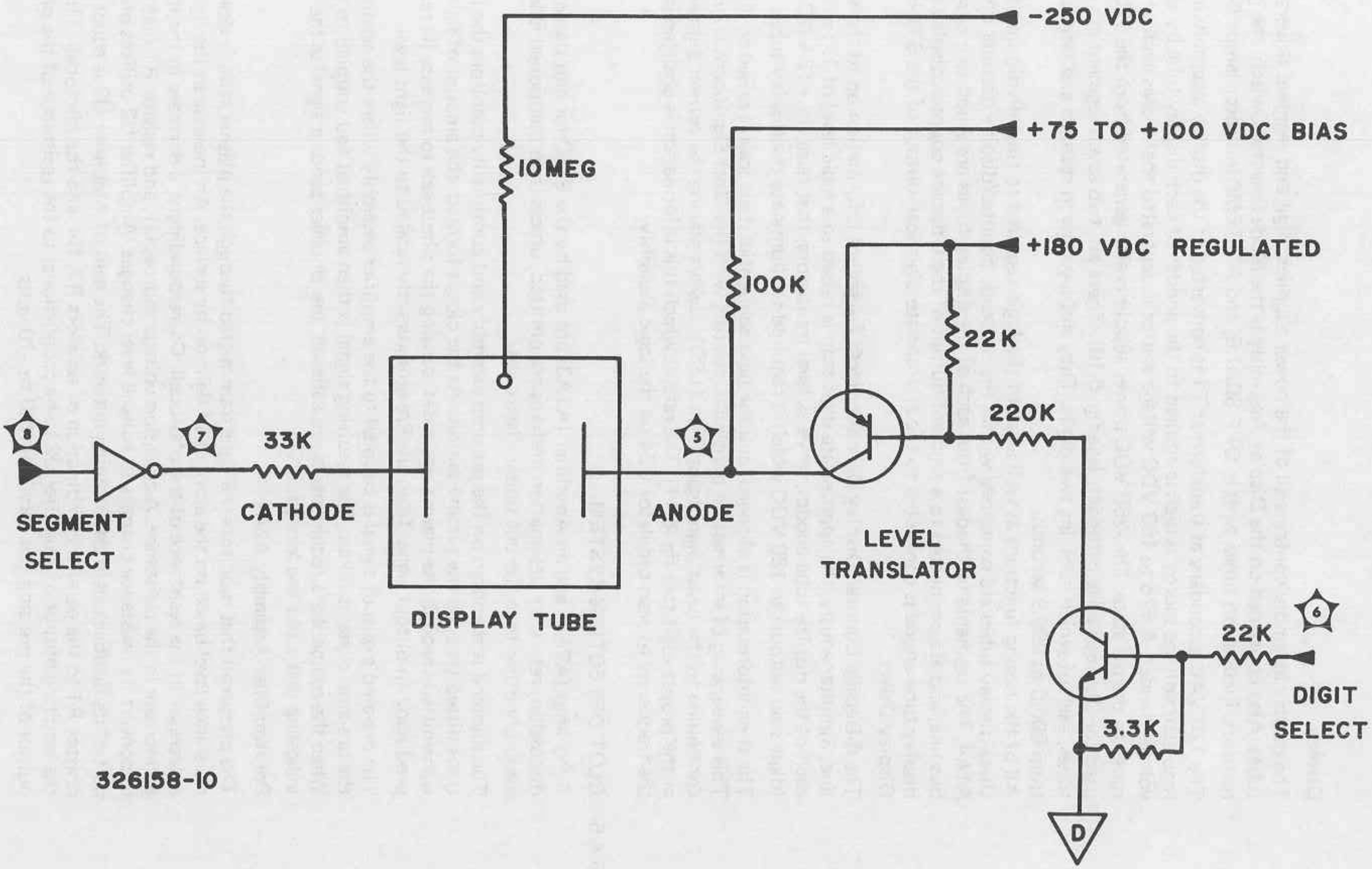

-250 VDC
+75 TO +100 VDC BIAS
+180 VDC REGULATED
10MEG
100K
22K
220K
22K
3.3K
8
7
5
6
33K
SEGMENT SELECT
CATHODE
ANODE
DISPLAY TUBE
LEVEL TRANSLATOR
DIGIT SELECT
D
326158-10

Figure 6-10. Display Circuit Simplified Schematic Diagram

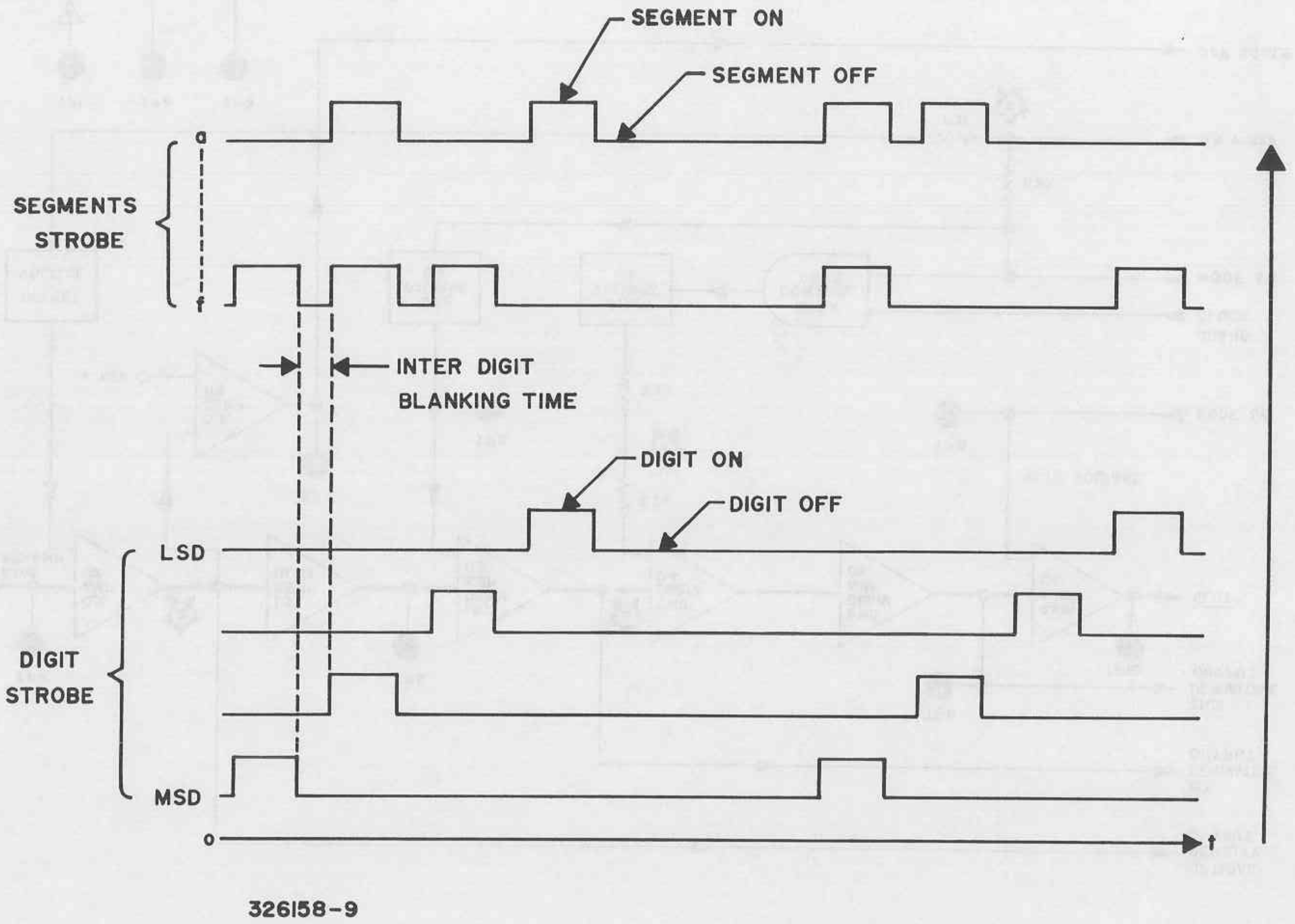

SEGMENT ON
SEGMENT OFF
a
SEGMENTS STROBE
f
INTER DIGIT BLANKING TIME
DIGIT ON
DIGIT OFF
LSD
DIGIT STROBE
MSD
o
t
V
326158-9

Figure 6-11. Display Timing Diagram

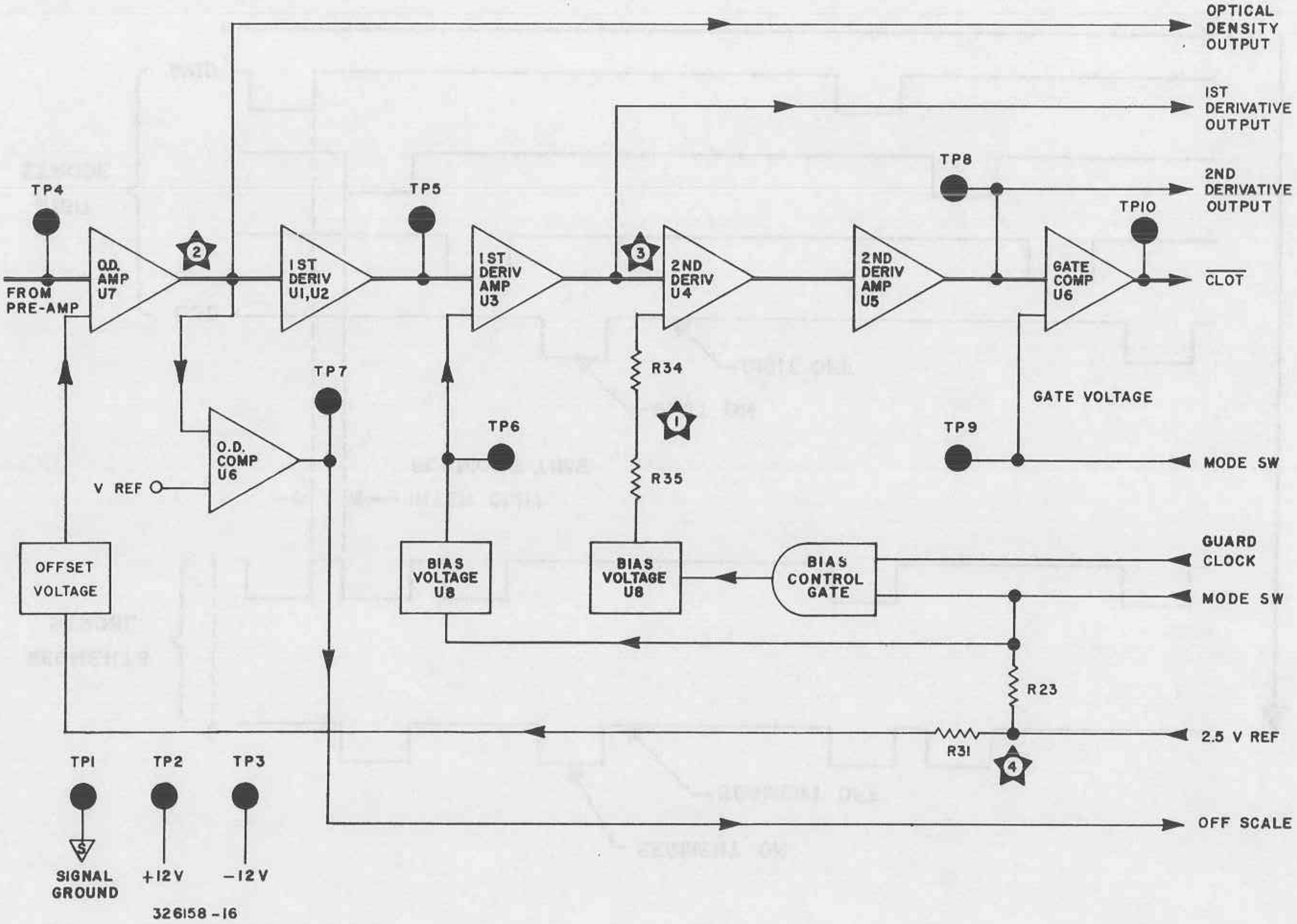

OPTICAL DENSITY OUTPUT
IST DERIVATIVE OUTPUT
2ND DERIVATIVE OUTPUT
TP8
TP4
TP5
TP10
FROM PRE-AMP
O.D. AMP U7
IST DERIV U1,U2
IST DERIV AMP U3
2ND DERIV U4
2ND DERIV AMP U5
GATE COMP U6
CLOT
TP7
O.D. COMP U6
V REF
TP6
R34
R35
GATE VOLTAGE
TP9
MODE SW
OFFSET VOLTAGE
BIAS VOLTAGE U8
BIAS VOLTAGE U8
BIAS CONTROL GATE
GUARD CLOCK
MODE SW
R23
R31
2.5 V REF
TP1
TP2
TP3
S
SIGNAL GROUND
+12V
−12V
326158-16
OFF SCALE
1
2
3
4

Figure 6-12. Amplifier Functional Block Diagram

Amplifier Assembly A1A3 (Figure 6-12)

The pre-amp output signal is coupled to optical density amplifier U7 and is offset to a normal 0.0VDC with maximum excursions of +10VDC. The output of amplifier U7 is coupled to first derivative amplifier U1, the off-scale detector, and the recorder interface.

The off-scale detector is a window comparitor that monitors the photocell's signal at the output of optical density amplifier U7 to insure that the photocell is operating within acceptable limits. When the voltage at the output of optical density amplifier U7 is outside the window, the output of the comparitor provides a high level, indicating that the sample is "off scale." The off-scale signal is measured at test point TP7. The limits of the photocell are measured as a voltage at test point TP4 and must be between -2.75 to -7.25VDC.

The output of amplifier U7 is also applied to first derivative amplifier U1. The magnitude of the voltage on the output in the first derivative amplifier, which is measured at test point TP5, is proportional to the rate at which the clot is forming in front of the photcell. The output of amplifier U1 is limited to a range approximately between -1.5 and +0.5 volts. The output of the signal from amplifier U3 through a capacitator performs the second derivative and applies this signal to amplifier U4. The input to the second derivative amplifier also has a large bias voltage placed as its input through a biasing network. Electronic switch U8 is an AND gate that requires that the instrument must be in PT, APTT, SPEC 1, or SPEC 2 mode and the guard clock interval has not expired. When these logical conditions have been satisfied, a 12V bias is placed at the input of amplifier U8A. However, when the guard clock interval has expired, the 12V bias voltage decays with 2.5 second time constant. In the THROMBIN mode, there is no bias voltage placed at the input to U4.

Amplifier U5 utilizes the output of second derivative amplifier U4 to form the second derivative signal that is presented to recorder output connector J1 at the rear of the instrument and is also the input to comparitor U6C. The second derivative output signal is measured at amplifier test point TP8. The output of the comparitor is measured at amplifier test point TP10. The comparitor monitors the output of the second derivative amplifier and compares it to a reference level that is determined by the mode switch position. The reference voltage is measured at amplifier test point TP9. When the input to the comparitor becomes nore negative than the fixed reference voltage, the output of the comparitor switches from 12V to 0V, indicating that a clot has been detected. These fixed reference voltages applied to the comparitor are shown in Table 6-2.

TABLE 6-2. GATE REFERENCE LEVELS

Mode	Guard	Comparitor Reference Level (A1A3-TP9)
PT	7.0	4.0 volts
APTT	16.0	0.5 volts
Thrombin	2.0	0.2 volts
SPEC 1	7.0	0.5 volts
SPEC 2	16.0	2.0 volts

There are three additional test points on the amplifier board: TP1, TP2, TP3. TP2 is the +12V power supply and TP3 is the -12V supply. TP1 is signal ground. All amplifier voltage measurements should be referenced to TP1. See section 7 for additional test points in the instrument.

Voltage of first derivative amplifier U1 is applied to amplifier U2 which, together with its associated components, permits only the negative going signal from the output of first derivative amplifier U1 to pass through to the remaining portions of the circuit. The bias voltage at the input of U2 places a minimum signal requirement on first derivative amplifier U1 output. For the PT, APPT, SPEC 1, and SPEC 2 modes, the bias voltage at the input of the amplifier U2 (test point TP6) is approximately +8.8 millivolts dc. When the instrument is in the THROMBIN mode, this bias is changed to about +2.8 mv dc.

CAUTION

These bias voltages are optimized at the factory under dynamic conditions. Do not change these settings unless special equipment and factory instructions are obtained.

The output of ideal diode U2 is then presented to amplifier U3 whose output is the first derivative signal presented to the recorder output at the rear of the instrument.

SECTION 7

TROUBLESHOOTING

7.1 LOGICAL TROUBLESHOOTING

This section contains information to aid in quickly and efficiently determining the cause of equipment malfunction. The information is given in order of overall troubleshooting technique, operational data, troubleshooting data, specific complaints, and test data relevant to troubleshooting.

7.1.1 Symptom Recognition

The first step in troubleshooting is to recognize the symptom. This is based on complete knowledge and understanding of the instrument's operating characteristics. All instrument troubles are not necessarily the direct result of component failure. Therefore, trouble is not always easy to recognize because all conditions of less than peak performance are not always apparent. This type of trouble is usually discovered while performing preventive maintenance procedures. It is important that the not so apparent troubles as well as the apparent troubles, be recognized. To assist in recognition of troubles, a troubleshooting checklist is provided. This procedure should be performed prior to performing specific troubleshooting procedures, either clot time complaint or electronic.

7.1.2 Symptom Elaboration

After an instrument trouble has been recognized, all the available aids designed into the instrument should be used to elaborate further on the original trouble symptom. Use of front-panel controls and AT-TEMP together with OFF SCALE indicators should provide better identification of the original trouble symptoms. Also, checking or otherwise manipulating the operating controls may eliminate the trouble.

7.1.3 Listing Probable Malfunction

The next step in logical troubleshooting is to formulate a number of logical choices as to the cause and likely location (functional section) of the trouble. The logical choices are mental decisions that are based on knowledge of the instrument's operation, a full identification of the trouble symptom, and information contained in this manual. The overall functional description and its associated block diagram should be referred to when selecting possible faulty sections.

7.1.4 Localizing Faulty Function

To obtain the greatest efficiency in localizing trouble, the functional sections that have been selected by the logical choice method should be tested in an order that will require the least time. This requires a mental selection to determine the section that should be checked first. The choice should be based on a further extension of the logical choice method. When the tests prove that the tested function is being performed properly, the next section should be tested and so on . . . until the faulty functional section is located. As aids in this process, this manual contains functional descriptions and simplified schematics diagrams. Also, where applicable, test data are supplied to augment functional descriptions, block diagrams and simplified schematics.

7.1.5 Localizing To The Circuit

After the faulty functional section has been isolated, it is often necessary to make additional logical choices as to which group of components or component (within the functional section) is at fault. A schematic diagram provides the information needed to bracket and isolate the faulty component, when this action is necessary.

7.1.6 Failure Analysis

After the trouble has been located, but prior to performing corrective action, the procedures followed up to this point should be reviewed to determine exactly why the fault affected the E750 in the manner it did. This review is usually necessary to make certain that the fault discovered is actually the cause of the malfunction, and not just the result of the malfunction. Prior to corrective action, a determination of the level to which the troubleshooting will be carried must be made. i.e. to the board level or the component level. To provide a shorter down time on the E750, board replacement is usually quicker than troubleshooting to the component level and replacing a component.

7.2 INTRODUCTION TO TROUBLESHOOTING PROCEDURES

The troubleshooting procedures are divided into two major categories (1) Clot Time Complaint and (2) Electronic Troubles. Prior to performing the procedures outlined in each of these procedures, the activities of the checklist should be performed. The procedures following the checklist are presented in tabular form and should be followed sequentially. The table should be entered at the point that describes the symptom or complaint and the probable causes checked until the malfunction is removed.

7.2.1 Clot Time Complaints

Clot time complaints take many forms. However, the most common complaints are variants of the following:

1. Poor duplication on a particular test (or all tests).
2. Control timer does not agree with a CAP or other survey.
3. Customers feel that the clot times are either shorter or longer than those to which they have been accustomed.
4. Clots not detected.

Very often these complaints are caused by poor testing technique bad reagents or materials (such as inadequate centrifugation, poor blood collection technique, bad vacutainers® etc.). The first thing to do when presented with a clot time complaint is to carefully question the customer about the exact nature of his problem. Using the flow charts that are provided in this troubleshooting section will help locate the procedure that deals with the specific clot time complaint. It often helps to go over this flow chart together with the customer. Flow charts are provided in this section for the following clot time complaints.

Table 7-1. Prolonged clot time. The clot times have suddenly become longer than the expected values.

Table 7-2. Short clot times. The clot times have suddenly become shorter than expected values.

Table 7-3. Poor reproducibility. How well duplicate pair clotting times agree is dependent on the type of clotting procedure being performed. Consult the operator's manual to determine if the instrument is operating within it's advertised limits.

Table 7-4. Missing clots. Determine if the complaint of missing clots means that there is only one single sample that cannot be detected, or many different samples. After completing the flow chart, make note of the section to which it refers. However, before proceeding to that section, complete the clot time complaint checklist, which is a listing of the most frequent causes of clot time complaints. If there are discrepancies between your findings and the checklist, correct the discrepancies and recheck the instrument to see if it has resolved the original clot time complaint. If it has, then proceed to paragraph 9-2 to insure that the entire instrument is functioning properly. However, if it hasn't then proceed to Troubleshooting, Section 7.

7.2.2 Clot Time Complaint Checklist

Perform the activities of this list prior to attempting to troubleshoot a clot time complaint.

1. Check that expiration dates have not been exceeded on reagents, control plasmas, and blood collection devices such as vacutainers ®. Manufacturers effectively state that their products will perform as claimed when used properly up to and including the expiration that is stamped on each vial of reagent, or controls. If that date has been exceeded they should be replaced with fresh products.
2. Check that lot numbers have not changed for reagents or control plasmas. Manufacturers cannot exactly duplicate the clotting characteristics or reagents, or control plasmas each time a new "lot" is prepared. Therefore, you should consult the packing inserts that are provided with every reagent and control so as to determine the accepted and allowable lot to lot variators.
3. Check that both reagents and controls are produced by the same manufacturer. Every reagent manufacturer, through their quality control procedures strive to maintain the integrity of their product line. However, they don't quality control their product with those of another manufacturer, therefore, in the event that the reagents and controls are produced by two or more different manufacturers, then each of the manufacturers should be consulted.

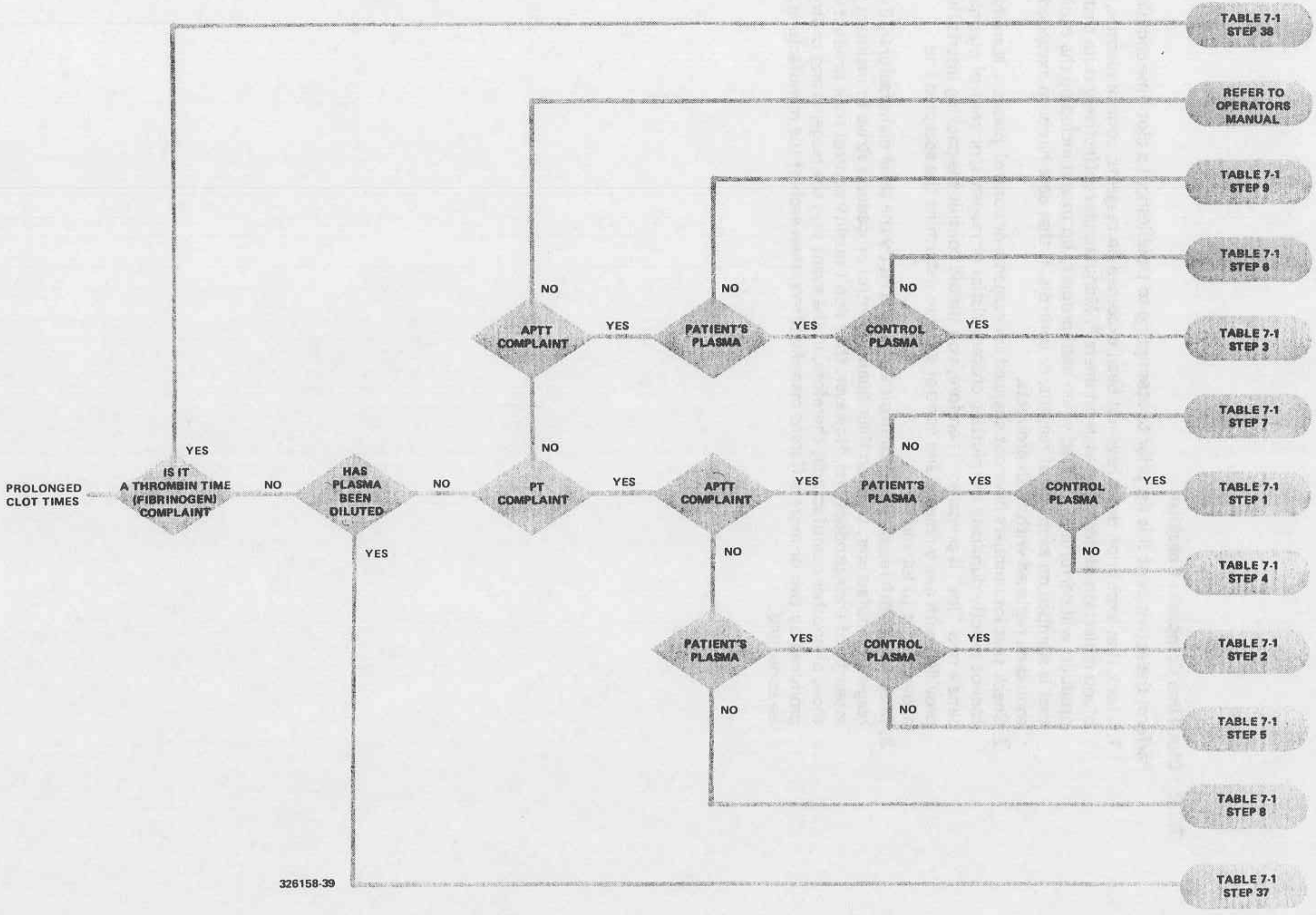

PROLONGED CLOT TIMES
IS IT A THROMBIN TIME (FIBRINOGEN) COMPLAINT
YES
NO
HAS PLASMA BEEN DILUTED
YES
NO
PT COMPLAINT
NO
YES
APTT COMPLAINT
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
NO
APTT COMPLAINT
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
NO
TABLE 7-1 STEP 38
REFER TO OPERATORS MANUAL
TABLE 7-1 STEP 9
TABLE 7-1 STEP 6
TABLE 7-1 STEP 3
TABLE 7-1 STEP 7
TABLE 7-1 STEP 1
TABLE 7-1 STEP 4
TABLE 7-1 STEP 2
TABLE 7-1 STEP 5
TABLE 7-1 STEP 8
TABLE 7-1 STEP 37
326158-39

Figure 7-1. Prolonged Clot Times – Troubleshooting Flow Chart

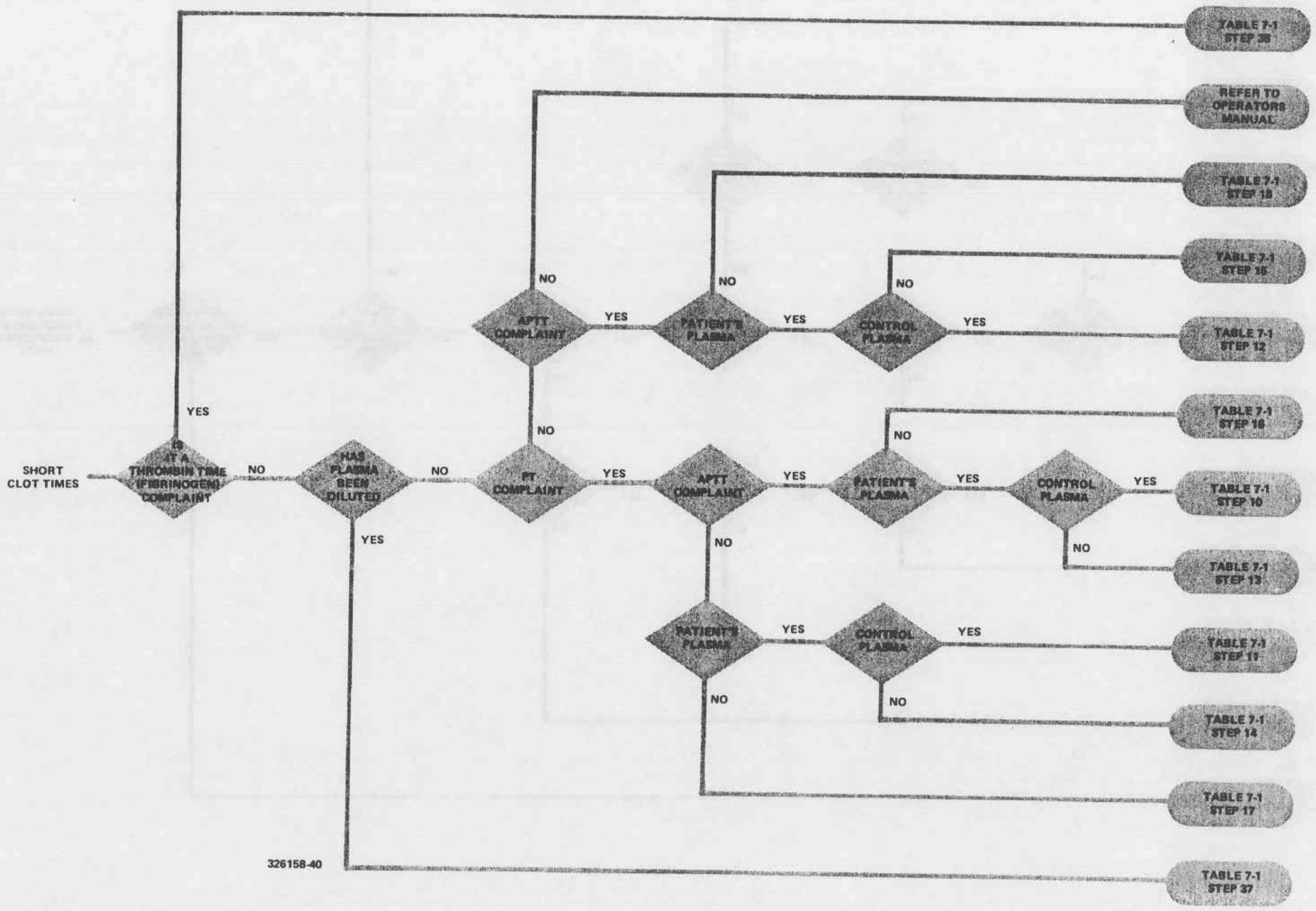

SHORT CLOT TIMES
IS IT A THROMBIN TIME (FIBRINOGEN) COMPLAINT
YES
NO
HAS PLASMA BEEN DILUTED
YES
NO
PT COMPLAINT
NO
YES
APTT COMPLAINT
NO
YES
PATIENT'S PLASMA
NO
YES
CONTROL PLASMA
NO
YES
APTT COMPLAINT
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
NO
TABLE 7-1 STEP 38
REFER TO OPERATORS MANUAL
TABLE 7-1 STEP 18
TABLE 7-1 STEP 15
TABLE 7-1 STEP 12
TABLE 7-1 STEP 16
TABLE 7-1 STEP 10
TABLE 7-1 STEP 13
TABLE 7-1 STEP 11
TABLE 7-1 STEP 14
TABLE 7-1 STEP 17
TABLE 7-1 STEP 37
326158-40

Figure 7-2. Short Clot Times – Troubleshooting Flow Chart

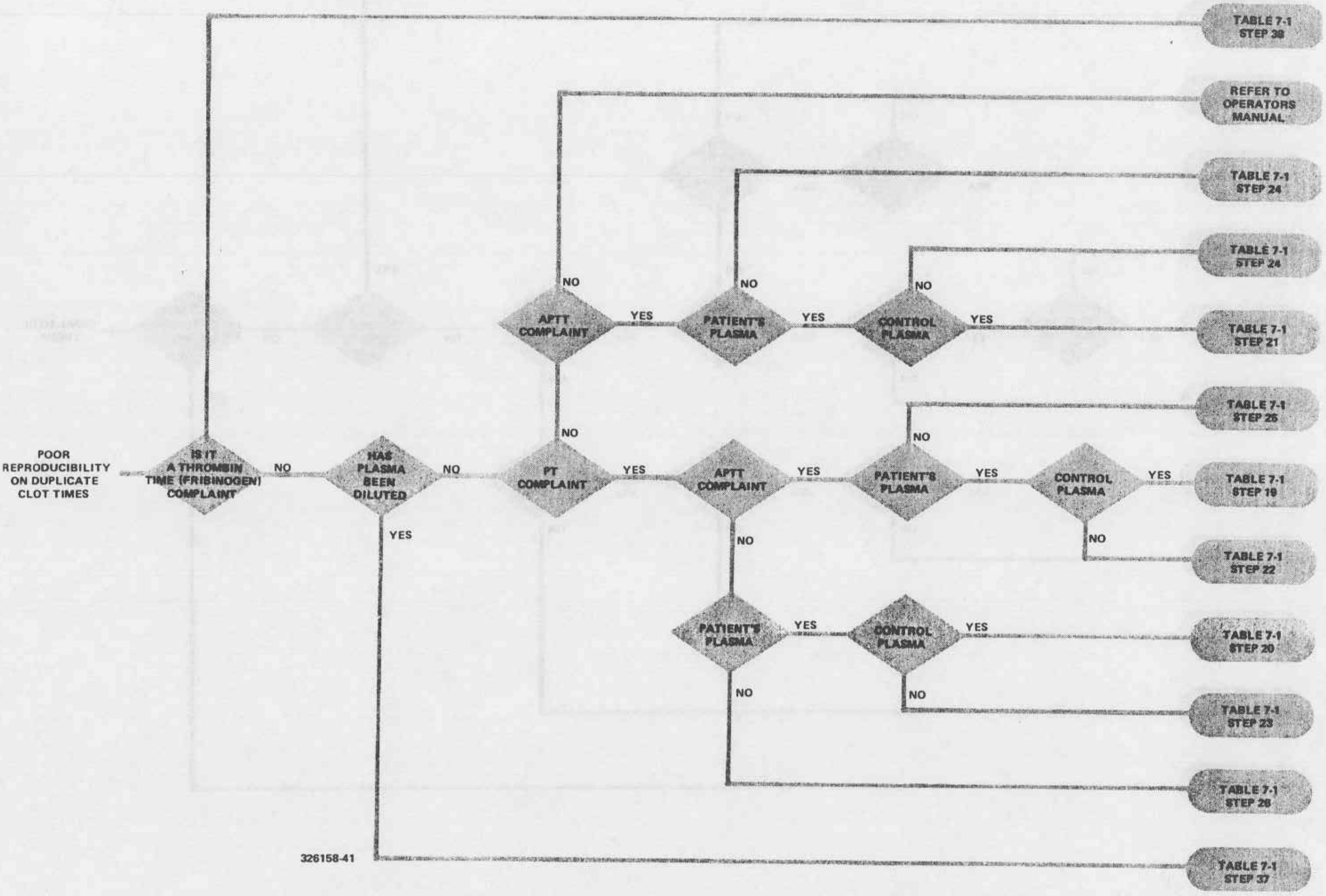

POOR REPRODUCIBILITY ON DUPLICATE CLOT TIMES
IS IT A THROMBIN TIME (FRIBINOGEN) COMPLAINT
NO
HAS PLASMA BEEN DILUTED
NO
YES
PT COMPLAINT
YES
NO
APTT COMPLAINT
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
NO
APTT COMPLAINT
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
NO
TABLE 7-1 STEP 38
REFER TO OPERATORS MANUAL
TABLE 7-1 STEP 24
TABLE 7-1 STEP 24
TABLE 7-1 STEP 21
TABLE 7-1 STEP 25
TABLE 7-1 STEP 19
TABLE 7-1 STEP 22
TABLE 7-1 STEP 20
TABLE 7-1 STEP 23
TABLE 7-1 STEP 26
TABLE 7-1 STEP 37
326158-41

Figure 7-3. Poor Reproducibility – Troubleshooting Flow Chart

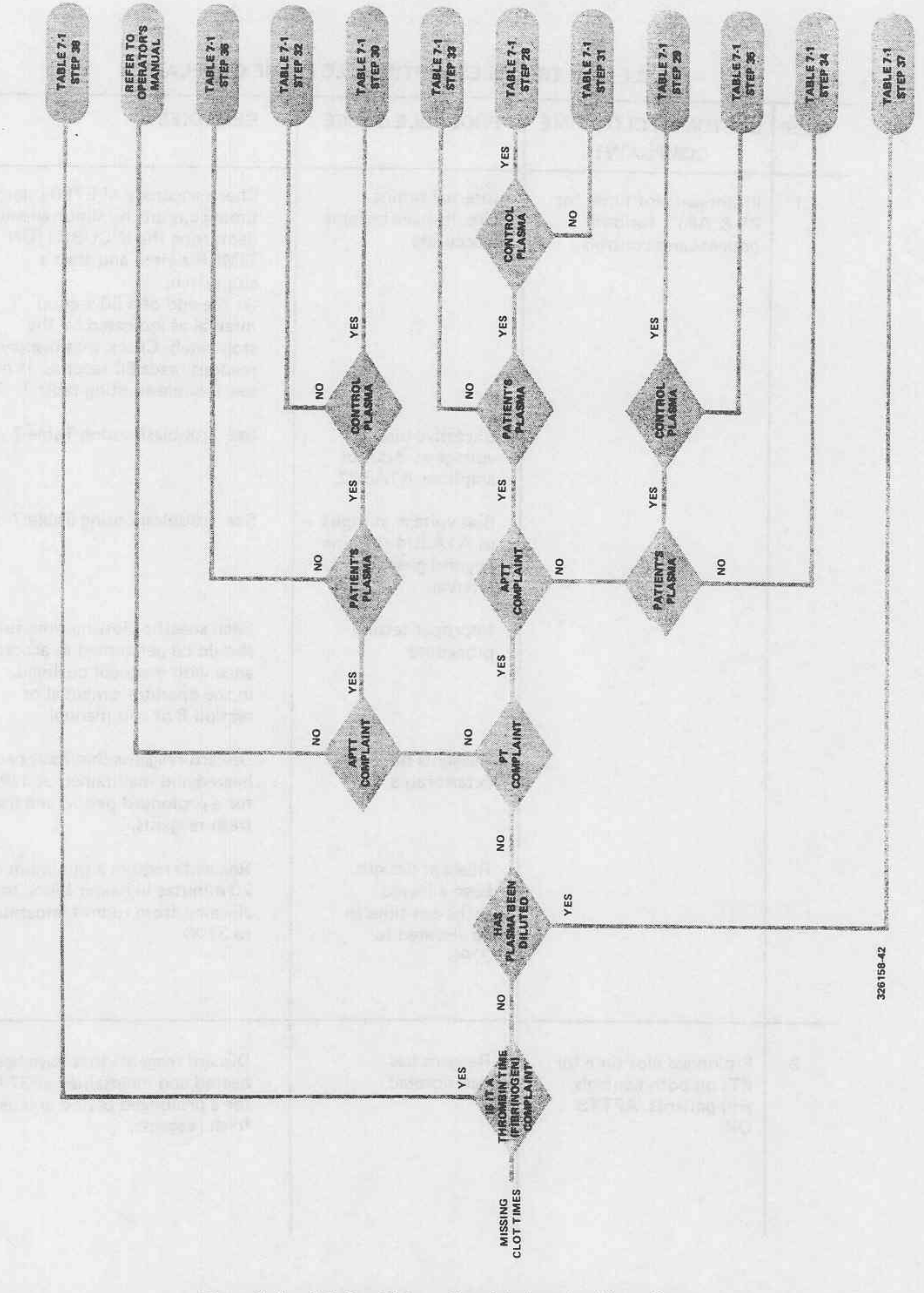

MISSING CLOT TIMES
IS IT A THROMBIN TIME (FIBRINOGEN) COMPLAINT
YES
NO
HAS PLASMA BEEN DILUTED
YES
NO
PT COMPLAINT
YES
NO
APTT COMPLAINT
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
NO
APTT COMPLAINT
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
NO
PATIENT'S PLASMA
YES
NO
CONTROL PLASMA
YES
TABLE 7-1 STEP 38
REFER TO OPERATOR'S MANUAL
TABLE 7-1 STEP 36
TABLE 7-1 STEP 32
TABLE 7-1 STEP 30
TABLE 7-1 STEP 33
TABLE 7-1 STEP 28
TABLE 7-1 STEP 31
TABLE 7-1 STEP 29
TABLE 7-1 STEP 35
TABLE 7-1 STEP 34
TABLE 7-1 STEP 37
326158-42

Figure 7-4. Missing Clots – Troubleshooting Flow Chart

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
1	Prolonged clot times for PT & APTT for both patients and controls	Internal timing circuits have become inaccurate	Check accuracy of E750 internal timing circuits by simultaneously depressing the INCUBATION TIMER switch and start a stopwatch. At the end of a 60 second interval as indicated by the stopwatch. Check that display readout reads 60 seconds. If not, see Troubleshooting table 7 - 2.
		Excessive bias voltage at input of amplifier A1A3U2	See Troubleshooting Table 7 - 2
		Bias voltage at input of A1A3U4 remains beyond guard clock interval.	See Troubleshooting Table 7 -2
		Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in the operator's manual or section 8 of this manual
		Reagents have deteriorated	Discard reagents that have been heated and maintained at 37°C for a prolonged period and use fresh reagents.
		Reagent has not been allowed sufficient time to be elevated to 37°C.	Reagents require a minimum of 20 minutes in heater block to be elevated from room temperature to 37°C.
2	Prolonged clot time for PTs on both controls and patients. APTTS OK	Reagent has deteriorated.	Discard reagents that have been heated and maintained at 37°C for a prolonged period and use fresh reagents.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
2 Con't		Improper testing procedure.	Each specific clotting time test should be done in accordance with the protocol outlined in the operator's manual or section 8 of this manual.
		Reagent has not been allowed sufficient time to be elevated to 37°C.	Reagents require a minimum of 20 minutes in heater block to be elevated from room temperature of 37°C.
3	Prolonged clot times for APTTs on controls and	Operator is using improper molar concentration of calcium chloride reagents.	Refer to packaging insert provided by each reagent manufacture for the proper calcium to use with air-activating reagents.
		Excessive bias voltage at input of amplifier A1A3U2	See Troubleshooting Table 7 - 2
		Bias voltage at input of A1A3U4 remains beyond guard clock interval	See Troubleshooting Table 7 - 2
		Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in the operator's manual or section 8 of this manual.
		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for a prolonged period and use fresh reagents.
		Reagent has not been allowed sufficient time to be elevated to 37°C.	Reagents require a minimum of 20 minutes in heater block to be elevated from room temperature to 37°C.
		Mode selector switch is improperly set.	Refer to operator's manual for the proper mode selector switch setting

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
4	Prolonged clot times for patients on both PTs and APTTs, controls OK.	Excessive bias voltage at input of amplifier A1A3U2	See Troubleshooting Table 7-2
		Bias voltage at input of amplifier A1A3U4 remains beyond guard clock interval.	See Troubleshooting Table 7 - 2.
		Improper testing procedure	Each specific clotting time test should be performed in accordance with the protocol as outlined in operator's manual or section 8 of this manual
		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.
		The PH of the anticoagulant that is used in the patient's plasma blood collection system has changed.	Measure PH of anticoagulant used in the blood collection system. If it exceeds 9, then the anticoagulant must be considered to have an excessive PH and be discarded.
		Wrong anticoagulant being used in patient's blood collection system.	See section 8 for proper anticoagulant to be used for blood coagulation.
		Vacuum in evacuated tube method of collecting patient plasma has lost vacuum and the system is now collecting erratically.	Proper ratios of patient plasma to anti-coagulants must be maintained. Discard defective tubes.
5	Prolonged PTs for patient's. PTTs and controls OK.	Reagents has not been allowed sufficient time to be elevated to 37°C	Reagents require a minimum of 20 minutes in heater block to be elevated from temperature to 37°C

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
5 Con't		Reagents have deteriorated	Discard reagents that have been maintained at 37ºC for prolonged periods and use fresh batch.
		Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
6	Prolonged APTTs for patient, PTs and controls OK.	Excessive bias voltage at input to amplifier A1A3U2	See Troubleshooting Table 7 - 2.
		Bias voltage at input to amplifier A1A3U4 remains beyond guard clock interval.	See Troubleshooting Table 7 - 2.
		Mode selector switch has been improperly set.	See operator's manual for proper mode selector switch position.
		Improper testing procedure	Each specific clotting time test must be performed in accordance with the protocol outlined in operator's manual or section 8 of this manual.
		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37ºC for prolonged periods and use fresh reagents.
		Samples have deteriorated.	Store plasma samples collected for APTT on ice, and test as soon as possible.
7	Prolonged PTs and APTTs for controls, patients OK.	Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
7 Con't		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.
		Reagent has not been allowed sufficient time to be elevated to 37°C	Reagents require a minimum of 20 minutes in heater block to be elevated from room temperature to 37°C.
8	Prolonged PTs for control plasma, PTTs and patients OK.	Improper testing procedure	Each specific clotting time test should be done in accordance with protocol that is outlined in operator's manual or section 8 of this manual.
		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.
		Reagent has not been allowed sufficient time to be elevated to 37°C	Reagents require a minimum of 20 minutes in heater block to be elevated from room temperature to 37°C.
9	Prolonged APTTs for controls patients and PTs OK.	Improper testing procedure.	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.
		Reagent has not been allowed sufficient time to be elevated to 37°C.	Reagents require a minimum of 20 minutes in heater block to be elevated from room temperature to 37°C.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
10	Short PT and APTT for both controls and patients.	Internal timing circuits have become inaccurate.	Check accuracy of internal timing circuits by simultaneously depressing INCUBATION TIMER switch and start stopwatch. After 60-second interval, as indicated by stopwatch, check that display reads 60 seconds. If not, see Troubleshooting Table 7 - 2.
		Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
11	Short PTs for both patients and controls PTTs are OK.	Improper testing procedure.	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
12	Short APTTs for both controls and patients, PTs are OK	Improper testing procedure	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual for section 8 of this manual.
		Using improper molar concentration of calcium chloride reagents.	Refer to packaging insert provided by each reagent manufacture for proper calcium to use with activating reagents. reagents.
		Excessive reference voltage at input of gate level comparitor A1A3U6C.	See Troubleshooting Table 7 - 2.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
13	Short PTs and APTTs for patients. Controls OK.	Improper testing procedure.	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
14	Short PTs for patients, PTTs and controls OK.	Improper testing procedure.	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
15	Short APTTs for patients, PTs and controls OK	Improper testing procedure.	Each specific clotting time test should be performed in accordance with prorocol outlined in operator's manual or section 8 of this manual.
16	Short PTs and APTTs for controls, patients OK	Improper testing procedure.	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
17	Short PTs for controls, APTTs and patients OK	Improper testing procedure.	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
18	Short APTTs for controls, patients and PTs OK.	Improper testing procedure.	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
19	Poor reproducibility on PTs and APTTs for both controls and patients.	Improper testing procedure.	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
19 Con't		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.
		Internal timing circuits have inaccurate	Check accuracy of E750 internal timing circuits by simultaneously depressing INCUBATION TIMER switch and start a stopwatch. At the end of a 60 second interval as indicated by the stopwatch. Check that display readout reads 60 seconds. If not, see Troubleshooting table 7 - 2.
		Photolamp has become noisy.	See Troubleshooting Table 7 - 2.
		Line voltage transient	Move E750 line cord to another outlet.
		The PH of the anticoagulant that is used in the patient's plasma blood collection system has changed.	Measure PH of anticoagulant used in the blood collection system. If it exceeds 9, then the anticoagulant must be considered to have an excessive PH and be discarded.
		Wrong anticoagulant being used in patient's blood collection system.	See section 8 for proper anticoagulant to be used for blood coagulation.
		Vacuum in evacuated tube method of collecting patient plasma has lost vacuum and the system is now collecting erratically.	Proper ratios of patient plasma to anti-coagulants must be maintained. Discard defective tubes.
20	Poor reproducibility for PTs on both patients and controls, PTTs OK.	Improper testing procedure.	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
20		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.
		Reagent has not been allowed sufficient time to be elevated to 37°C	Reagents require a minimum of 20 minutes in heater block to be elevated from room temperature to 37°C.
21	Poor reproducibility for APTTs on both controls and patients. PTs OK.	Improper testing procedure.	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manyal or section 8 of this manual.
		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.
		Excessive bias voltage at input of amplifier A1A3U2	See Troubleshooting Table 7 - 2.
		Bias voltage at input of A1A3U4 remains beyond guard clock interval.	See Troubleshooting Table 7 - 2.
		Reagent has not been allowed sufficient time to be elevated to 37°C	Reagents require a minimum of 20 minutes in the heater block to be elevated from room temperature to 37°C.
		Using improper molar concentration of calcium chloride reagents.	Refer to packaging insert provided by each reagent manufacture for proper calcium to use with activating reagents.
22	Poor reproducibility for PTs and PTTs on patients, Controls OK.	Reagents have deteriorated.	Discard reagents that have been maintained at temperature of 37°C for prolonged periods. Use fresh batch.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
22 Con't		Improper testing procedure.	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		The PH of the anti-coagulant that is used in the patient's plasma blood collection system has changed.	Measure PH of anticoagulant used in the blood collection system. If it exceeds 9, then the anticoagulant must be considered to have an excessive PH and be discarded.
		Wrong anticoagulant being used in patient's blood collection system.	See section 8 for proper anticoagulant to be used for blood coagulation.
		Vacuum in evacuated tube method of collecting patient plasma has lost vacuum and the system is now collecting erratically.	Proper ratios of patient plasma to anti-coagulants must be maintained. Discard defective tubes.
23	Poor reproducibility for PTs on patients, PTTs and controls OK	Reagents have deteriorated	Discard reagents that have been maintained at temperature of 37°C for prolonged period and use fresh reagents.
		Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
24	Poor reproducibility on APTTs for Patients, PTs and controls OK	Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
24 Con't		Reagent has not been allowed sufficient time to be elevated to 37°C	Reagents require a minimum of 20 minutes in heater block to be elevated from room temperature to 37°C.
		Mode selector switch has been improperly set.	See operator's manual for proper mode selector switch position.
25	Poor reducibility on PTs and APTTs for controls. Patients are OK	Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.
		Reagent has not been allowed sufficient time to be elevated to 37°C	Reagents require a minimum of 20 minutes in heater block to be elevated from room temperature to 37°C.
26	Poor reproducibility on PTs and APTTs for controls. Patients are OK	Improper testing procedure.	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Reagents have deteriorated.	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.
		Reagent has not been allowed sufficient time to be elevated to 37°C	Reagents require a minimum of 20 minutes in heater block to be elevated from room temperature to 37°C.
27	Poor reproducibility on APtts for controls PTs and patients OK.	Reagents have deteriorated	Discard reagents that have been maintained at temperature of 37°C for prolonged periods and use fresh reagents.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
27 Con't		Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
28	Missing clots on PTs and APTTs for both controls and patients.	Reagents have deteriorated	Discard reagents that have been maintained at temperature of 37°C for prolonged period and use fresh reagents.
		Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Power supply assembly A1A1 is defective	See Troubleshooting Table 7 - 2.
		Excessive bias voltage at input of amplifier A1A3U3	See Troubleshooting Table 7 - 2.
		Bias voltage at input of amplifier A1A3U4 remain beyond guard clock interval.	See Troubleshooting Table 7 - 2.
		Excessive reference voltage at input of gate level comparitor A1A3U6C.	See Troubleshooting Table 7 - 2.
		Defective clot verifier timer	See Troubleshooting Table 7 - 2.
		Guard clock interval timer is defective.	See Troubleshooting Table 7 - 2.
		Mode selector switch is set to improper position.	Refer to operator's manual for proper mode selector switch setting.
		Clot time is shorter than guard interval time.	See operator's manual for specific clotting time procedure to determine if there is an alternate mode available.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
29	Missing PTs on both controls and patients, APTTs OK	Reagents have deteriorated	Discard reagents that have been maintained at temperature of 37oC for prolonged periods and use fresh reagents.
		Improper testing procedure	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Guard interval timer for PT mode is defective	See Troubleshooting Table 7 - 2.
		Excessive reference voltage at input of gate level comparitor A1A3U6C.	See Troubleshooting Table 7 - 2. procedures.
		Clot time is shorter than guard interval time.	See operator's manual for specific clot time procedure to determine if there is an alternate mode available.
30	Missing APTTs on both controls and patients, PTs OK.	Reagents have deteriorated	Discard reagents that have been maintained at temperature of 37oC for prolonged periods. Use fresh batch.
		Improper testing procedure	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Excessive bias voltage at input of amplifier A1A3U2.	See Troubleshooting Table 7 - 2.
		Bias voltage at input of amplifier A1A3U4 remains beyond guard clock interval.	See Troubleshooting Table 7 - 2.
		Excessive reference voltage at input of gate level comparitor A1A3U6C.	See Troubleshooting Table 7 - 2.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
30 Con't		Clot time is shorter than guard interval time.	See operator's manual for specific clot time procedure to determine if there is an alternate mode available.
		Guard clock interval timer for APTT mode is defective	See Troubleshooting Table 7 - 2.
		Operator is using improper molar concentration of calcium chloride reagents.	Refer to packaging insert provided by each reagent manufacture to determine the proper calcium to use with air-activating reagents.
31	Missing PTs and APTTs for patients, controls OK.	Reagents have deteriorated	Discard reagents that have been heated and maintained at 37°C for prolonged periods and use fresh reagents.
		Improper testing procedure.	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		The PH of the anticoagulant that is used in the patient's plasma blood collection system has changed.	Measure PH of anticoagulant used in the blood collection system. If it exceeds 9, then the anticoagulant must be considered to have an excessive PH and be discarded.
		Wrong anticoagulant being used in patient's blood collection system.	See section 8 for proper method and proper anticoagulant to be used for blood coagulation.
		Vacuum in evacuated tube method of collecting patient plasma has lost vacuum and the system is now collecting erratically.	Proper ratios of patient plasma to anti-coagulants must be maintained. Discard defective tubes.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
31		Clot time is shorter than guard interval time.	See operator's manual for specific clot time procedure to determine if there is an alternate mode available.
		Improper testing procedure	Each specific clotting time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
32	Missing APTTs for patients, PTs and controls OK	Reagents have deteriorated	Discard reagents that have been maintained at temperature of 37°C for prolonged periods and use fresh reagents.
		Improper testing procedure	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Excessive bias voltage at input to amplifier A1A3U2	See Troubleshooting Table 7 - 2.
		Bias voltage at input to amplifier A1A3U4 remains beyond guard clock interval.	See Troubleshooting Table 7 - 2.
		Mode selector switch improperly set.	Refer to operator's manual for proper mode selector switch setting.
		Clot time is shorter than guard interval time.	See operator's manual for specific clot time procedure to determine if there is an alternate mode available.
33	Missing PTTs and APTTs for controls, patients OK.	Reagents have deteriorated	Discard reagents that have been maintained at temperature of 37°C for prolonged periods. Use fresh batch.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
33 Con't		Improper testing procedure	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Clot time is shorter than guard interval time.	See operator's manual for specific clot time procedure to determine if there is an alternate mode available.
34	Missing PTs for controls, APTTs and patients OK	Reagents have deteriorated	Discard reagents that have been maintained at temperature of 37°C for prolonged periods and use fresh reagents.
		Improper testing procedure	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Clot time is shorter than guard interval time.	See operator's manual for this specific clot time procedure to determine if there is an alternate mode available.
35	Missing PTs for patients, APTTs and controls, OK	Reagents have deteriorated	Discard reagents that have been maintained at temperature of 37°C for prolonged periods and use fresh reagents.
		Improper testing procedure	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Clot time is shorter than guard interval time.	See operator's manual for this specific clot time procedure to determine if there is an alternate mode available.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
36	Missing APTTs for controls, PTs and patients OK	Improper testing procedure	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Clot time is shorter than guard interval time.	See operator's manual for this specific clot time procedure to determined if there is an alternate mode available.
		Reagents have deteriorated.	Discard reagents that have been maintained at temperature of 37°C for prolonged periods and use fresh reagents.
37	Missing 12-1/2% saline dilutions.	Improper testing procedure.	Each specific clot time test should be performed in accordance with protocol outlined in operator's manual or section 8 of this manual.
		Clot time is shorter than guard interval time.	See operator's manual for this specific clot time procedure to determine if there is an alternate mode available.
		The saline dilutions of specimens are not being prepared properly.	Refer to section 8 of operator's manual for proper procedure to prepare saline dilutions.
		The saline dilution curve is not being prepared from a normal control plasma or a fresh normal pool.	See section 8 of operator's manual related to materials necessary for preparing a saline dilution curve.
		Excessive bias voltage at input of amplifier A1A3U2.	See Troubleshooting Table 7 - 2.
		Bias voltage input input of amplifier A1A3U4 remains beyond guard clock interval.	See Troubleshooting Table 7 - 2.
		Mode selector switch is improperly set.	Refer to operator's manual for proper mode selection switch setting.

TABLE 7 - 1. TROUBLESHOOTING CLOT TIME COMPLAINTS

STEP	CUSTOMER CLOT TIME COMPLAINT	PROBABLE CAUSE	REMEDIES
38	Unable to perform any Fibrinogen determinations via the thrombin time method.	Excessive bias voltage at input of amplifier A1A3U2.	See Troubleshooting Table 7 - 2.
		Bias voltage exist at input of amplifier A1A3U4 beyond guard clock interval.	See Troubleshooting Table 7 - 2.
		Improper testing procedures.	Specific clot time procedure must be performed in accordance with protocol as outlined in operator's manual.
		Reagents have deteriorated. A thrombin reagent is a highly labile reagent and should be used as soon as posible after reconstitution.	Discard reagent.
		Using wrong diluant to prepare test sample.	Only buffered diluants such as Owrens Veronal Buffer can be used in preparing specimens.
		Using improper dilution ratios in preparing test sample.	Refer to section 8 of operator's manual for thrombin time procedure.
		Mode selector switch improperly set.	Refer to operator's manual for the proper mode selector switch setting.
		Thrombin reagent is being stored at 37^{o}C	Thrombin reagent should be stored at room temperature to insure a maximum reagent life.
		Not using proper volume of reagent to initiate thrombin time procedure.	See section 8 of operator's manual for proper test procedures in performing thrombin times.

7.2.3 Electronic Troubleshooting

The E750 contains complex electronic circuitry that will be easy to troubleshooting if a systematic approach is used. Sufficient data is included for that purpose. The first activity should be to perform the procedures of the electronic trouble checklist.

Electronic Troubleshooting Checklist

Before any troubleshooting, of the electronic assemblies is attempted, the following checklist should be completed:

1. Check that Electra 750 is connected to A/C power source.
2. Check at rear panel, that 50-60 HZ switch is in its proper position. See Section 4 for proper setting.
3. Check at rear panel, that voltage selector is set to proper voltage range see Section 4 for proper settings and procedure.
4. Remove top sheet metal cover as outlined in general disassembly procedure. Pull cover interlock switch to UP position. Measure and record following voltages at Test Points (TP) indicated.

a. On the amplifier assembly (A1A3) measure (Referenced to signal ground (A1A3-TP1) at A1A3-TP2 + 12.0 VDC ±0.2 VDC, and at A143-TP3, a -12 VDC ± 0.2VDC.

b. Measure Lamp Voltage Power Supply at side of heater block at terminal board (TB1) following lamp voltages. These voltages are measured at TB1-1 and TB1-2.

Lamp Lever Switch Position	**Voltages**
A	5.50 VDC ± 0.1 VDC
B	4.25 VDC ± 0.1 VDC
C	3.50 VDC + ± 0.05 VDC

TABLE 7 - 2. **TROUBLESHOOTING ELECTRONIC MALFUNCTIONS**

STEP	SYMPTOM	PROBABLE CAUSE	REMEDIES
1	Indicators do not light.	Line fuse F1 open.	Check primary power for short. Repair Short Circuit. See Figure 11-3.
		Defective cover interlock switch S1.	Replace cover interlock switch S1.
		Defective relay A1A2K1.	Replace AC Power-heater Assembly A1A2.
		Defective transformer T1.	Replace transformer T1.
		Connector A2A2J8 is disconnected from Mother Board A1.	Re-engage connector, A2A2J8.
		Defective power ON-OFF switch A2S1.	Replace power ON-OFF switch A2S1
2	Timing display tubes do not light.	Defective 170 v secondary winding in transformer T1.	Replace transformer T1.
		Defective contact on relay A1A2K1.	Replace the AC Power-heater PC Assembly A1A2.
		Defective Ribbon Cable Assembly A2A2 ①	Replace Display Assembly A2A2.
		Defective-250 VDC A2A2 ②	Replace Display Assembly A2A2.
		Defective + 180 VDC Power Supply A2A2 ④	Replace Display Assembly A2A2.
		Defective Digit Scan A2A2 ⑤	Replace Logic Assembly A1A4.
		Defective Segment scan A2A2 ⑧	Replace Logic Assembly A1A4.
		Defective Segment Driver A2A2 ⑦	Replace Display Assembly A2A2.

TABLE 7 - 2. TROUBLESHOOTING ELECTRONIC MALFUNCTIONS

STEP	SYMPTOM	PROBABLE CAUSE	REMEDIES
		Defective Digit Driver A2A2 ⑥	Replace Display Assembly A2A2.
		Defective Display Tube.	Replace Display Tube.
3	Timing indicators light, but not bright.	Defective 170 v AC secondary winding of the transformer T1.	Replace transformer T1.
		Defective relay contact on relay A1A2K1.	Replace the AC Power-Heater Assembly A1A2.
		Defective Ribbon Cable assembly on A2A2 ①	Replace Display Assembly A2A2.
		Defective + 180 v DC Power Supply A2A2 ④	Replace Display Assembly A2A2.
		Defective Digit Scan A2A2 ⑤	Replace Logic Assembly A1A4.
		Defective Segment Scan A2A2 ⑧	Replace Logic Assembly A1A4.
		Defective Segment Driver A2A2 ⑦	Replace Display Assembly A2A2.
		Defective Digit Drive A2A2 ⑥	Replace Display Assembly A2A2.
		Defective Display Tube.	Replace Display Tube.
4	Timing indicators count too slowly.	Defective 170 v AC secondary winding on transformer T1.	Replace T1.

TABLE 7 - 2. TROUBLESHOOTING ELECTRONIC MALFUNCTIONS

STEP	SYMPTOM	PROBABLE CAUSE	REMEDIES
		Defective 50/60 cycle selector switch	Replace the 50/60 cycle selector switch S4.
		Defective 50/60 cycle clock A1A2 ☆1	Replace the AC Power-Heater Assembly, A1A2.
		Defective connection between A1A2 and A1A4, A1A4 ☆4	Troubleshoot for bad connection.
		Defective 0.1 second clock A1A4 ☆2	Replace Logic Assembly A1A4.
		Defective 6 Decade Counter/Display Decoder A1A4U21.	Replace 6 Decade Counter/Display Decoder A1A4U21.
5	Timing Indicators count, too fast.	Defective 170 v AC winding or transformer T1.	Replace T1.
		Defective 50/60 cycle selector switch S4.	Replace the 50/60 cycle selector switch S4.
		Defective 50/60 cycle clock A1A2 ☆1	Replace the AC Power-Heater Assembly A1A2.
		Defective connection between A1A2 and A1A4, A1A4 ☆4	Troubleshoot for bad connection.
		Defective 0./second clock A1A4 ☆2	Replace Logic Assembly A1A4.
		Defective 6 Decade Counter/Display Decoder A1A4U21.	Replace 6 Decade Counter/Display Decoder A1A4U21.
6	Timing indicators count erratically.	Defective 170 v AC secondary winding in transformer T1.	Replace T1.

TABLE 7 - 2. TROUBLESHOOTING ELECTRONIC MALFUNCTIONS

STEP	SYMPTOM	PROBABLE CAUSE	REMEDIES
		Defective 50/60 cycle selector switch S4.	Replace 50/60 cycle selector switch S4.
		Defective 50/60 cycle clock A1A2 ①	Replace the AC Power-Heater Assembly A1A2.
		Defective connection between A1A2 and A1A4, A1A4 ④	Troubleshoot for bad connection.
		Defective 0.1/second clock A1A4 ②	Replace Logic Assembly A1A4.
		Defective 6 Decade Counter/Display Decoder A1A4U21.	Replace 6 Decade Counter/Display Decoder A1A4U21.
7	Timing displays take a long time to light.	Defective 170 v secondary winding in transformer T1.	Replace transformer T1.
		Defective contact on relay A1A2K1.	Replace the AC Power-Heater Assembly A1A2.
		Defective Ribbon Cable Assembly A2A2 ①	Replace Display A2A2.
		Defective-250 VDC Power Supply A2A2 ②	Replace Display Assembly A2A2.
		Defective + 180 VDC Power Supply A2A2 ④	Replace Display Assembly A2A2.
		Defective Display Tube.	Replace Display Tube.
8	At Temp. indicator does not illuminate and the heater block is at 37.2° C.	Defective A-Temp. Temperature Detector A1A2 TP 4.	Replace AC Power-Heater Assembly A1A2.

TABLE 7 - 2. TROUBLESHOOTING ELECTRONIC MALFUNCTIONS

STEP	SYMPTOM	PROBABLE CAUSE	REMEDIES
		Defective OPTO-ISOLATOR A1A2 ②	Replace AC Power-Heater Assembly A1A2.
		Defective At Temp. Lamp Driver A1A3 ⑤	Replace Logic Assembly A1A4.
		Defective At Temperature Lamp A2A2DS2.	Replace AT-TEMP Lamp A2A2DS2.
9	Heater Block Temperature ambient temperator.	Thermal fuse A2F1 is open. If Block Temperature goes above 55° C fuse will open.	Replace thermal fuse A2F1.
		Defective thermistor A1A2-TP5.	Replace Thermistor A2R1.
		Defective Heat Control Detector A1A2-TP2.	Replace AC Power-Heater Assembly A1A2.
		Defective Triac A1A2Q2, A1A2 TP3.	Replace AC Power-Heater Assembly A1A2.
		Defective Block Heater element A2R2.	Replace Block heater element A2R2.
10	Heater Block Temperature is too low 37.2° C±0.2° C.	Heat Block required temperature adjustment A1A2 TP5.	Adjust Heater Block Temperature.
		Defective Thermistor A2R1, A1A2 TP5.	Replace Thermistor A1A2R1.
		Defective Heat Control Detector, A1A2 TP2.	Replace AC Power-Heater Assembly A1A2.

TABLE 7 - 2. TROUBLESHOOTING ELECTRONIC MALFUNCTIONS

STEP	SYMPTOM	PROBABLE CAUSE	REMEDIES
		Defective Triac A1A2 TP3.	Replace AC Power-Heater Assembly A1A2.
		Defective Block Heater element A2R2.	Replace Block Heater element A2R2.
11	Heater Block Temperature too high.	Heater Block Temperature is only adjustment A1A2 TP5.	Adjust Heater Block Temperature (paragraph 10.2.6).
		Defective Thermistor A1A2 TP5.	Replace Thermistor A2R1.
		Defective Heat Control Detector, A1A2 TP2.	Replace AC Power-Heater Assembly A1A2.
		Defective Triac A1A2 TP3.	Replace AC Power-Heater Assembly A1A2.
		Defective Block heater element A2R2.	Replace Block heater element A2R2.
12	The At-Temp. indicator lights intermittenly.	Defective Thermistor A2R1, A1A2 TP5.	Replace Thermistor A2R1.
		Defective Heat Control Detector, A1A2 TP2.	Replace AC Power-Heater Assembly A1A2.
		Defective Triac, A1A2 TP3.	Replace AC Power-Heater Assembly A1A2.
		Defective AT-TEMP Detector A1A2-TP4.	Replace AC Power-Heater Assembly A1A2.
		Defective OPTO-ISOLATOR A1A2	Replace AC Power-Heater Assembly A1A2.

TABLE 7 - 2. TROUBLESHOOTING ELECTRONIC MALFUNCTIONS

STEP	SYMPTOM	PROBABLE CAUSE	REMEDIES
		Defective AT TEMP Lamp Driver A1A3 ⑤	Replace Logic Assembly A1A4.
		Defective AT-TEMP LAMP A2A2DS2.	Replace AT-TEMP. A2A2DS2.
		Defective Block heater element A2R1.	Replace Block heater A2R1.
13	OFF-SCALE indicator lights all the time.	A defective Lamp Level selector switch S3.	Replace the A-B-C Lamp Switch Assembly S3.
		The photolamp has become darkened or fails to illuminate.	Replace the Photlamp assembly A2DS1.
		Obstruction in optical path.	Remove obstruction.
		2.5 VDC reference voltage defective A1A3 ④	Replace pre-amp assembly A2A1.
		Photocell pre-amp assembly defective A1A3-TP4.	Replace Pre-Amp Assembly A2A1.
		Defective AT-Temperature comparitor A1A3-TP7.	Replace the AC Power-Heater Assembly A1A2.
		Defective OFF-SCALE Lamp Driver A1A4 ⑧	Replace Logic Assembly A1A4.
		Defective OFF-SCALE Lamp A2A2DS1.	Replace defective OFF-SCALE Lamp A2A2DS1.

TABLE 7 - 2. TROUBLESHOOTING ELECTRONIC MALFUNCTIONS

STEP	SYMPTOM	PROBABLE CAUSE	REMEDIES
14	The OFF-SCALE indicator does not light when the lamp level is switched to the "A" or "C: positions, as indicated in the OCT test.	Defective lamp level selector switch.	Replace the A-B-C lamp switch assembly A3.
		Photolamp has become darkened or fails to illuminate at all.	Replace the Photo-lamp Assembly A2DS1.
		Obstruction in optical path.	Remove the obstruction.
		2.5 VDC reference voltage defective A1A3 ④	Replace Pre-Amp Assembly A2A1.
		The Photocall Pre-Amp Assembly has become defective A1A3-TP4.	Replace Pre-Amp Assembly A2A1.
		A defective AT Temp. comparitor A1A2-TP7.	Replace AC Power-Heater Assembly A1A2.
		Defective OFF-SCALE Lamp Driver A1A4 ⑥	Replace Logic Control P/C Board Assembly A1A4.
		Defective OFF-SCALE Lamp A2A2DS1.	Replace defective OFF-SCALE Lamp A2A2DS1.
15	Timers do not operate when incubation time switch is depressed.	Tube in test well.	Remove tube from test well. In order for the incubation timer to function, the conditions are such that there is no tube in test station.
		Defective Incubation "START-STOP" switch A1A4 ⑧	Replace the Display Assembly A2A2.

TABLE 7 - 2. TROUBLESHOOTING ELECTRONIC MALFUNCTIONS

STEP	SYMPTOM	PROBABLE CAUSE	REMEDIES
		A defective tube detector switch A1A4 9	Replace the Tube Detector Switch A2S3.
		Defective Logic Assembly.	Replace the Logic Assembly A1A4.
16	Timing sequence does not start for a test cycle when pipette plunger is depressed.	No tube in the test station.	Place tube in test well.
		Defective Timing Start Switch A1A4.	Replace Time START Switch A2S2.
		Defective Tube Detector Switch A1A4 9	Replace Tube Detector Switch A2S3.
		Defective Logic Assembly.	Replace Logic Assembly A1A4.
17	Time resets to zero when tube is removed from test station.	Tube removed from test well before clot was detected.	Allow clot timer to STOP before removing tube.
		Defective incubation time switch, A1A4 8	Replace Display Assembly A2S2.
		Defective Tube Detector Switch A1A4 9	Replace Tube Detector Switch A2S3.
		Defective Logic Assembly.	Replace Logic Assembly A1A4.

TABLE 7 - 2. TROUBLESHOOTING ELECTRONIC MALFUNCTIONS

STEP	SYMPTOM	PROBABLE CAUSE	REMEDIES
18	Timing indicator does not reset to zero when next tube is inserted into test station.	Defective Tube Detector Switch A1A4	Replace Tube Detector Switch A2S3.
		Defective Logic Assembly A1A4.	Replace Logic Assembly.
19	Guard clock interval does not expire in any mode.	Defective mode selector switch A2A2S2.	Replace Display Assembly A2A2S2.
		Defective Logic Assembly A1A4.	Replace Logic Assembly A1A4.

7.2.4 Test Point and Waveform Data

Tables 7-3 through 7-6 present the signal description and waveform that appears at the indicated test point (TP) or circuit point (indicated by a star ☆).

The condition under which the specific waveform is obtained is also given, when applicable. Each table represents a major assembly in the instrument.

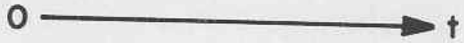
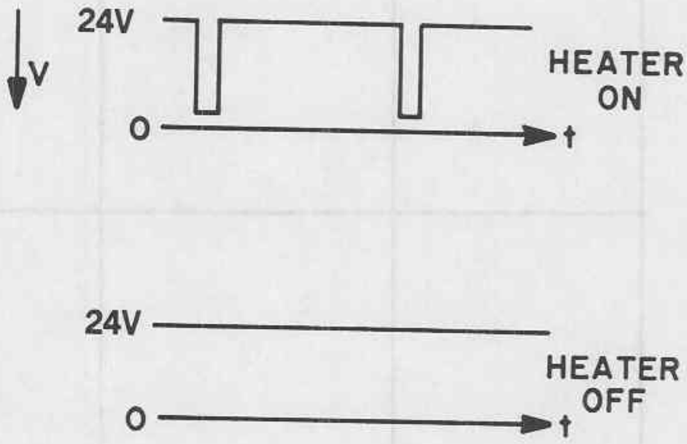
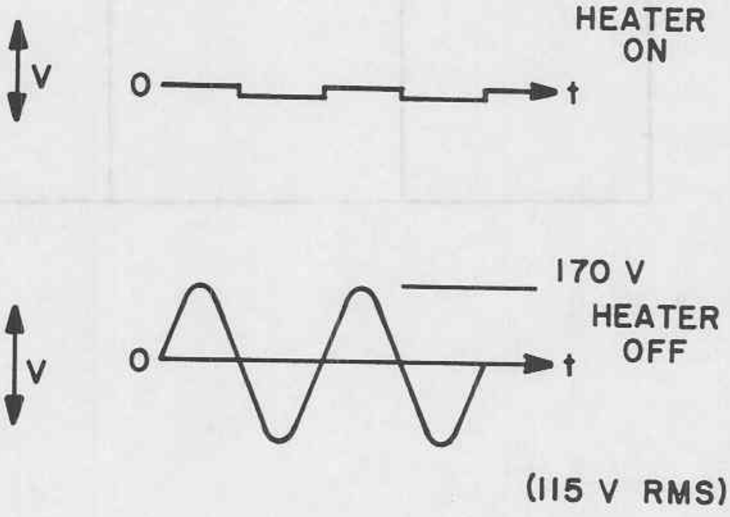
When an anticipated waveform is not obtained, check the nearest preceeding test point or circuit point for its proper signal. When the proper signal or waveform is obtained, the malfunctioning circuit is between those two points. A blank form is included for adding waveforms to your own test points.

TEST POINT	SIGNAL DESCRIPTION	WAVEFORM

TABLE 7-3

TEST POINT AND WAVEFORM DATA FOR AC POWER–HEATER P/C BD ASSEMBLY A1A2

(1 of 2)

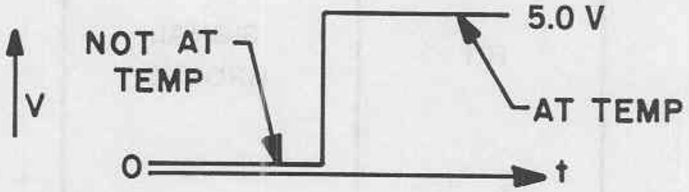
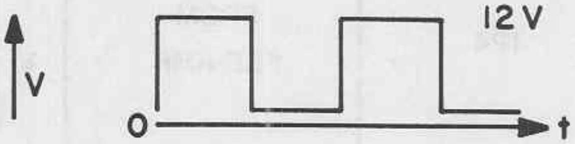
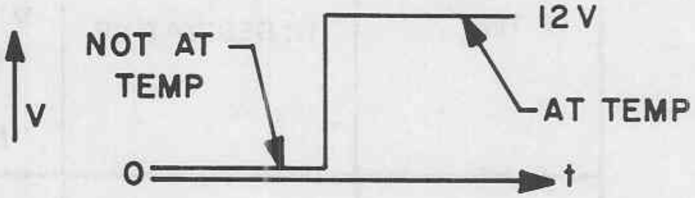
TEST POINT	SIGNAL DESCRIPTION	WAVEFORM
TP1*	0 VAC PRIMARY TAP (NEUTRAL)	
TP2*	TRIAC GATE PULSE VOLTAGE	 24V V HEATER ON O t 24V HEATER OFF O t
TP3*	HEATER VOLTAGE	 HEATER ON V O t 170 V HEATER OFF V O t (115 V RMS)

* VOLTAGE MEASURED REFERENCED TO TP1 (0 VAC NEUTRAL)

TABLE 7-3

TEST POINT AND WAVEFORM DATA FOR AC POWER–HEATER P/C BD ASSEMBLY A1A2

(2 of 2)

TEST POINT	SIGNAL DESCRIPTION	WAVEFORM
TP4*	AT TEMP	 V NOT AT TEMP 5.0 V AT TEMP 0 t
TP5*	THERMISTOR VOLTAGE	FOR LOW TEMP. TP5 > TP6 WHEN AT TEMP. TP5 = TP6 FOR HIGH TEMP. TP5 < TP6
TP6*	THERMISTOR REFERENCE VOLTAGE	3.00 VDC ± 0.3 VDC
①	50 - 60 HZ CLOCK	 NOTE: REF TO DIGITAL GROUND
②	AT TEMP TO LOGIC	 V NOT AT TEMP 12 V AT TEMP 0 t NOTE: REF TO DIGITAL GROUND

*VOLTAGE MEASURED REFERENCED TO TP1 (0 VAC NEUTRAL)

TABLE 7 - 4

TEST POINT AND WAVEFORM DATA FOR AMPLIFIER P/C BD ASSEMBLY A1A3

(1 of 3)

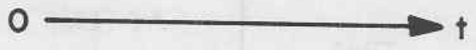
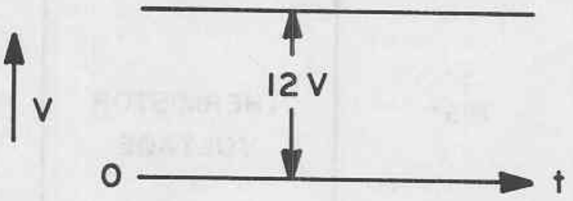
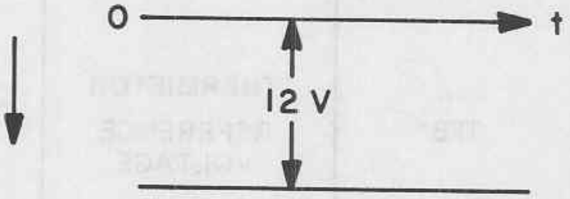
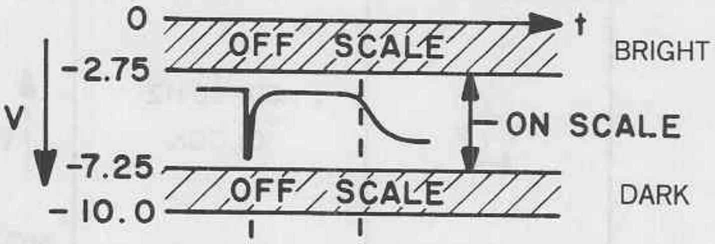
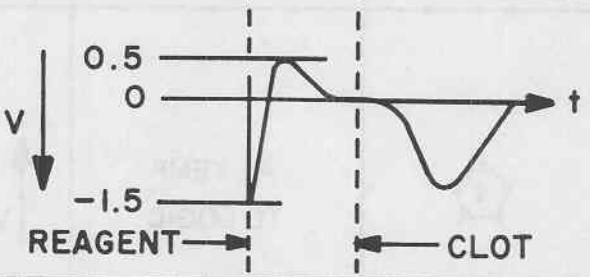
TEST POINT	SIGNAL DESCRIPTION	WAVEFORM
TP1	SIGNAL GROUND	
TP2	+12.0 VDC ± 0.1 VDC	
TP3	−12.0 VDC ± 0.1 VDC	
TP4	FROM PRE-AMP	 0 t OFF SCALE BRIGHT −2.75 V ON SCALE −7.25 OFF SCALE DARK − 10.0
TP5	1st DERIVATIVE	 0.5 0 t V −1.5 REAGENT CLOT

TABLE 7-4
TEST POINT AND WAVEFORM DATA FOR AMPLIFIER P/C BD ASSEMBLY A1A3
(2 of 3)

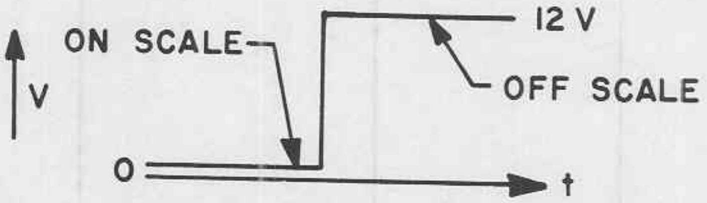
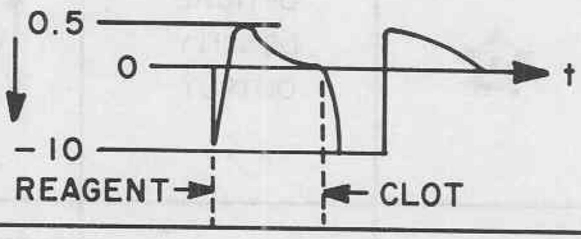
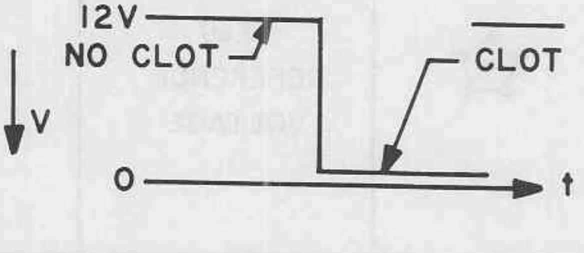
TEST POINT	SIGNAL DESCRIPTION	WAVEFORM
TP6	1st DERIVATIVE BIAS VOLTAGE	THROMBIN MODE ≈ 4 MVDC ALL OTHER MODES ≈ 10 MVDC NOTE: THESE ARE FACTORY SET AND SHOULD NOT BE RESET
TP7	OFF SCALE	 V ON SCALE 12 V OFF SCALE 0 t
TP8	2nd DERIVATIVE	 0.5 V 0 t - 10 REAGENT CLOT
TP9	GATE VOLTAGE	P.T. = - 4.0 VDC A.P.T.T. = - 0.5 VDC THROMBIN = - 0.2 VDC SPEC. 1 = - 0.5 VDC SPEC. 2 = - 2.0 VDC
TP10	$\overline{\text{CLOT}}$	 12V NO CLOT CLOT V 0 t

TABLE 7 - 4
TEST POINT AND WAVEFORM DATA FOR AMPLIFIER P/C BD ASSEMBLY A1A3

(3 of 3)

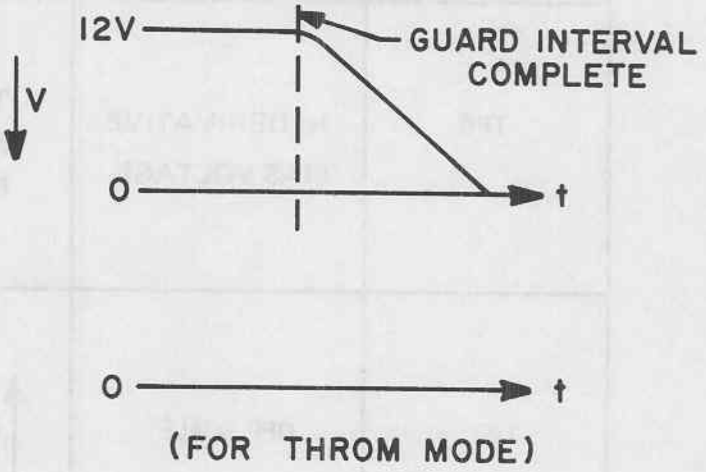
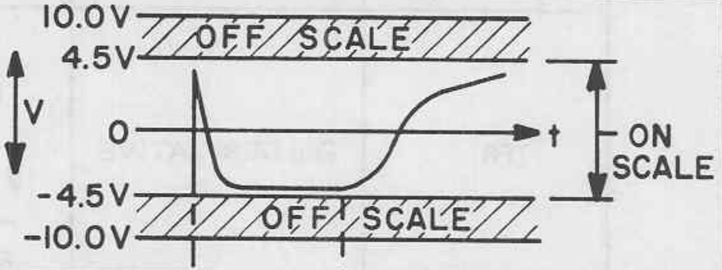
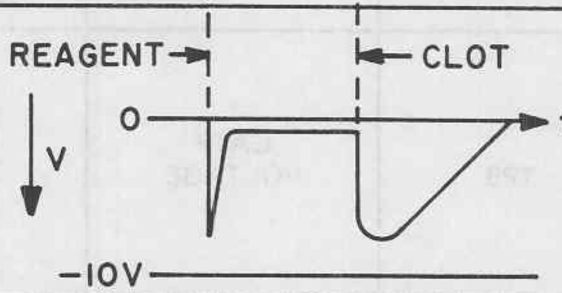
TEST POINT	SIGNAL DESCRIPTION	WAVEFORM
①	2nd DERIVATIVE BIAS VOLTAGE	
②	OPTICAL DENSITY OUTPUT	
③	1st DERIVATIVE AMPLIFIER OUTPUT	
④	+2.50 REFERENCE VOLTAGE	+ 2.5 VDC ± 0.1 VDC

TABLE 7 - 5

TEST POINT AND WAVEFORM DATA FOR DISPLAY P/C BD ASSEMBLY A2A2

(1 of 2)

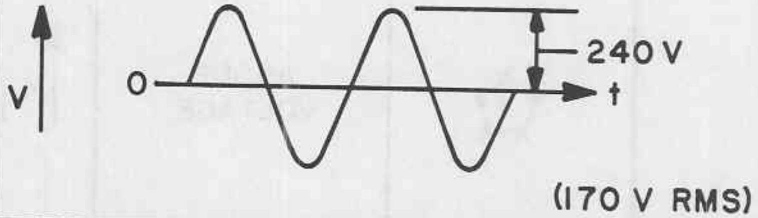
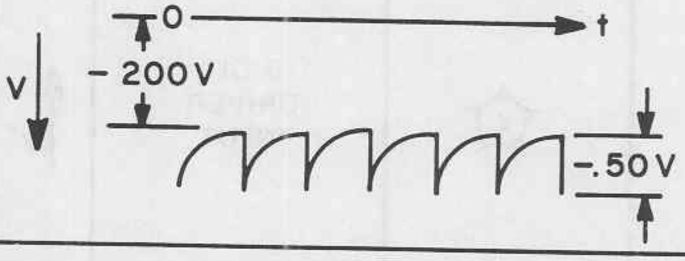
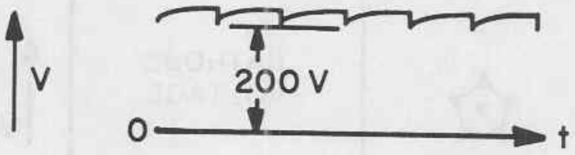
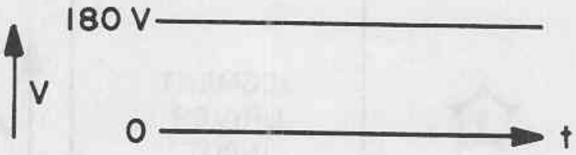
TEST POINT	SIGNAL DESCRIPTION	WAVEFORM
1	170 VAC SECONDARY	 V 0 240 V t (170 V RMS)
2	−250 VDC POWER SUPPLY FOR KEEP ALIVE CATHODE	 V 0 t - 200 V -.50 V
3	+180 VDC UNREGULATED POWER SUPPLY	
4	+180 VDC REGULATED POWER SUPPLY	

TABLE 7-5

TEST POINT AND WAVEFORM DATA FOR DISPLAY P/C BD ASSEMBLY A2A2

(2 of 2)

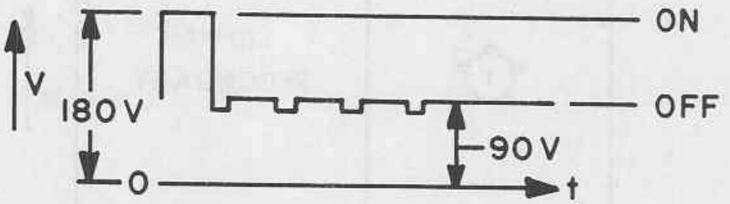
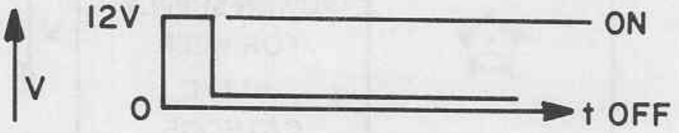
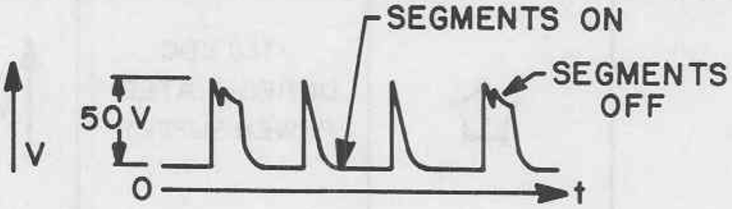
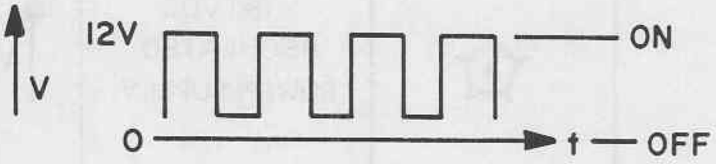
TEST POINT	SIGNAL DESCRIPTION	WAVEFORM
5	ANODE VOLTAGE	 V 180 V 0 ON OFF 90 V t
6	DIGIT DRIVER INPUT	 V 12V 0 ON t OFF f = 166 HZ
7	CATHODE VOLTAGE	 SEGMENTS ON SEGMENTS OFF V 50 V 0 t
8	SEGMENT DRIVER INPUT	 V 12V 0 ON t OFF

TABLE 7 - 6

TEST POINT AND WAVEFORM DATA FOR LOGIC P/C BD ASSEMBLY A1A4

(1 of 3)

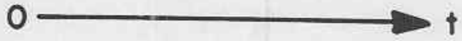
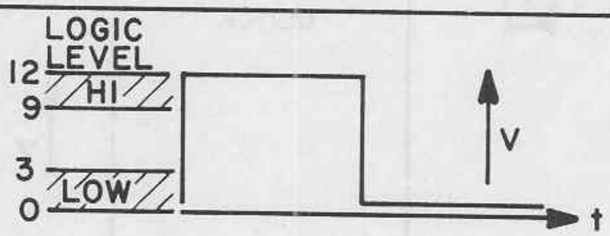
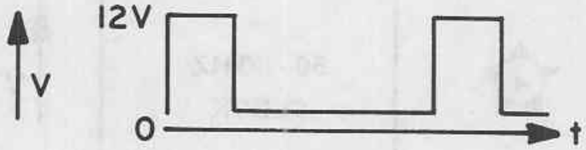
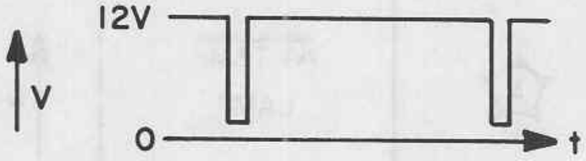
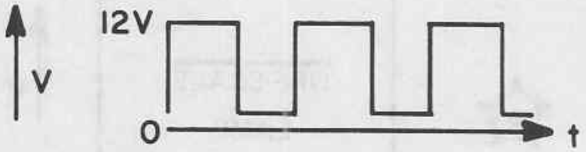
TEST POINT	SIGNAL DESCRIPTION	WAVEFORM
GRD	DIGITAL GROUND	
$\emptyset_0$ $\emptyset_1$ $\emptyset_2$	3 - BIT STATE COUNTER	 LOGIC LEVEL 12 HI 9 3 LOW 0 V t
CP	CLOCK PULSE FROM 0.1 DIGIT SCAN TO LOAD GUARD CLOCK INTERVAL	 f = 166 HZ
①	CLOCK PULSE FOR STATE COUNTERS	
②	SCAN OSCILLATOR	 f = 1K HZ

TABLE 7 - 6

TEST POINT AND WAVEFORM DATA FOR LOGIC P/C BD ASSEMBLY A1A4

(2 of 3)

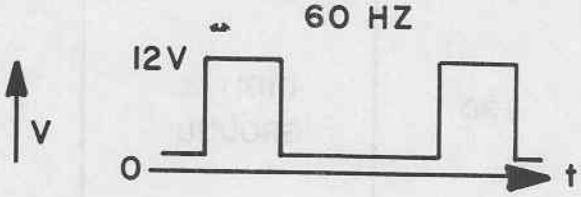
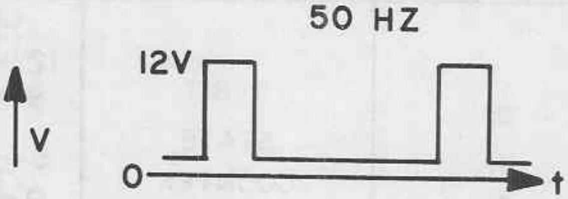
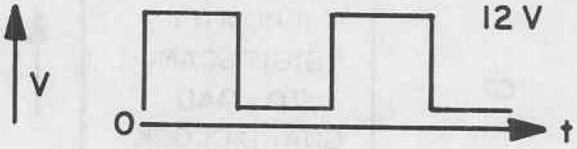
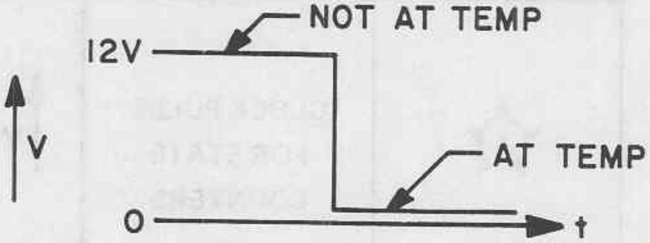
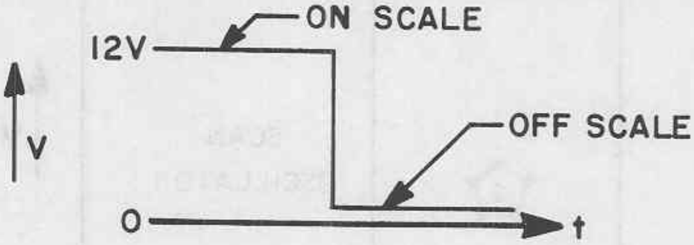
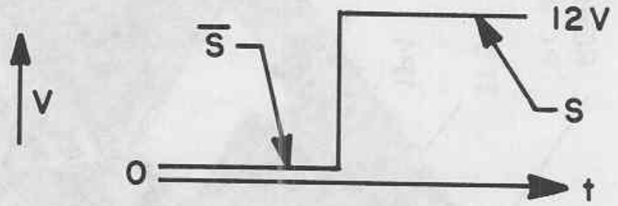
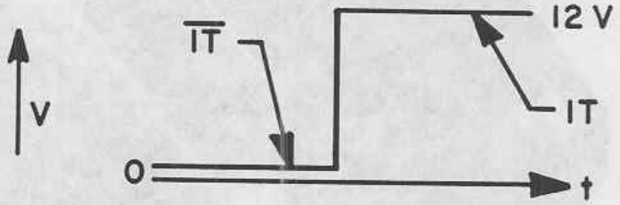
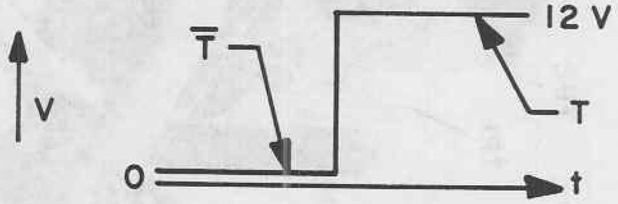
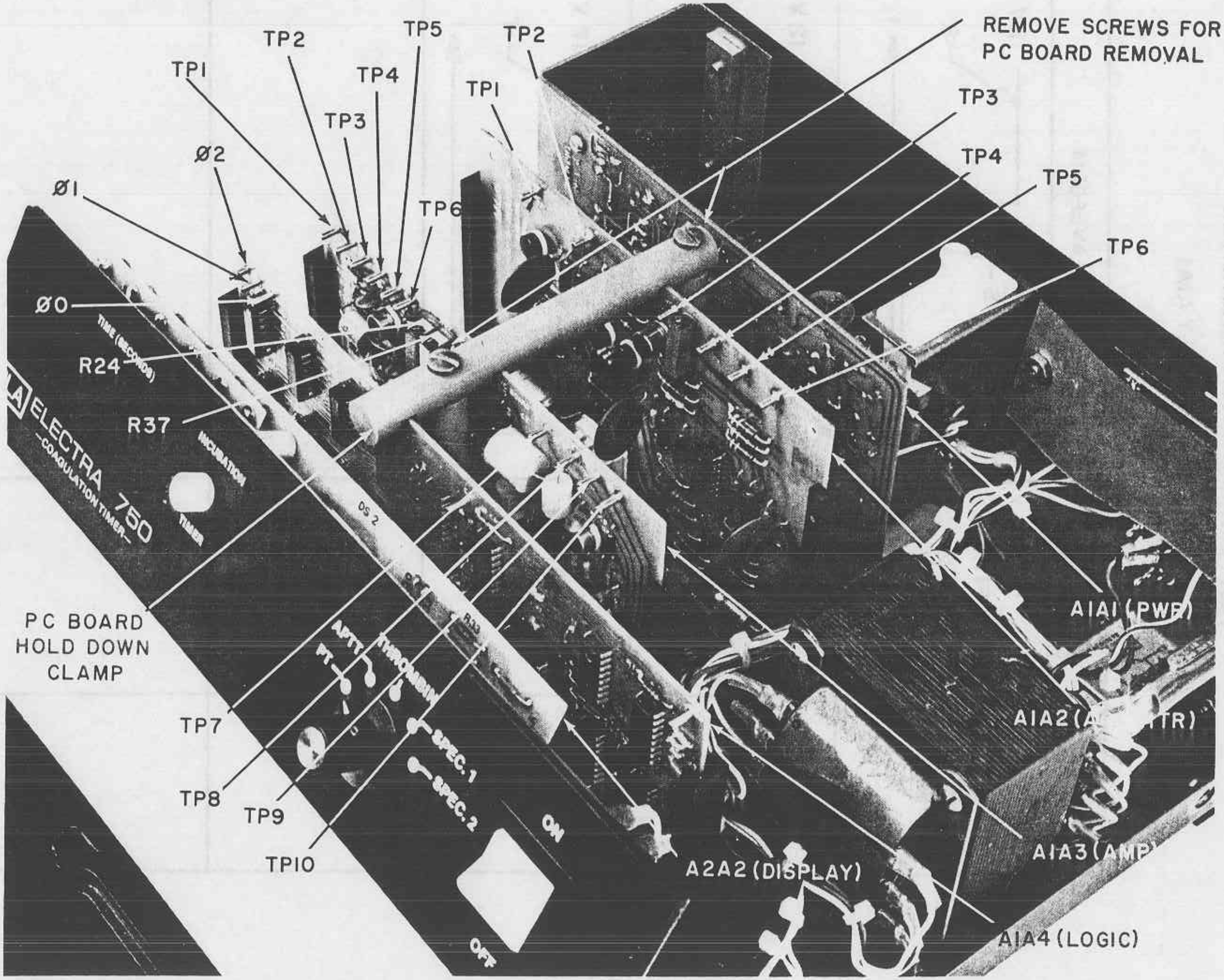
TEST POINT	SIGNAL DESCRIPTION	WAVEFORM
3	0.1 SECOND CLOCK	 60 HZ 12V V 0 t  50 HZ 12V V 0 t NOTE: ONLY WHEN INSTRUMENT IS TIMING
4	50 - 60 HZ CLOCK	
5	$\overline{\text{AT TEMP}}$ LAMP	 NOT AT TEMP 12V AT TEMP V 0 t
6	$\overline{\text{OFF SCALE}}$ LAMP	 ON SCALE 12V OFF SCALE V 0 t

TABLE 7 - 6

TEST POINT AND WAVEFORM DATA FOR LOGIC P/C BD ASSEMBLY A1A4

(3 of 3)

TEST POINT	SIGNAL DESCRIPTION	WAVEFORM
7	TIME START SWITCH (S)	 V $\overline{S}$ 12 V S 0 t
8	INCUBATION TIMER SWITCH (IT)	 V $\overline{IT}$ 12 V IT 0 t
9	TUBE DETECT SWITCH (T)	 V $\overline{T}$ 12 V T 0 t


REMOVE SCREWS FOR PC BOARD REMOVAL
TP1
TP2
TP3
TP4
TP5
TP6
Ø0
Ø1
Ø2
R24
R37
TP1
TP2
TP3
TP4
TP5
TP6
PC BOARD HOLD DOWN CLAMP
TP7
TP8
TP9
TP10
A2A2 (DISPLAY)
A1A1 (PWR)
A1A2 (A
TR)
A1A3 (AMP)
A1A4 (LOGIC)
ELECTRA 750
COAGULATION TIMER
TIME (SECONDS)
INCUBATION
TIMER
DS 2
PT
APTT
THROMBIN
SPEC. 1
SPEC. 2
ON
OFF

326158 — 44

Figure 7.5 Location of Test Points

SECTION 8

COAGULATION TESTING

8.1 INTRODUCTION

This section describes operating protocols for performing specific coagulation tests. Specific information on operation of the Electra 750 is contained in Section V, Operation. The operator should have a thorough knowledge of the material in Section V before proceeding in this section.

8.2 SPECIMEN COLLECTION

It is important that blood be collected with generally accepted good practice in order to obtain valid coagulation results. Collection should be accomplished by a clean venipuncture and collected in a plastic syringe or siliconized glass tube. The anti-coagulant should be either 3.8% sodium citrate or 0.1 m sodium oxalate in a ratio of 9 parts blood to 1 part anti-coagulant. EDTA and sodium heparin are generally not acceptable anti-coagulants for coagulation studies. After collection, the blood specimens should be centrifuged as soon as possible and the plasma removed from the cells. Recommended centrifugation is 1000 RCF (g's) for 15 minutes, unless otherwise noted. Specimens are to be kept cold while stored, and should be tested as soon as possible. In general, all plasma should be tested within 4 hours of being drawn.

8.3 PREPARATION OF REAGENTS AND CONTROLS

8.3.1 Basic Rules Governing Reagents and Controls

a) All reagents and controls should be reconstituted according to the manufacturer's instructions. Use only de-ionized, distilled water for reconstitution.

b) Use clean glassware. Glassware should be cleaned in chromic acid solution.

c) Reagents and controls should be reconstituted gently. When mixed, they should be rocked and never shaken unless otherwise noted.

d) Reconstituted reagents should sit for at least 15 minutes before using for test. Gently rock prior to using.

e) Run controls in duplicate before and after each test run.

f) Use the same lot number of reagent and control for all the tests. Record the lot numbers and expiration dates for all reagents and controls used.

8.3.2 Preparation of Calcium Chloride

Molarity	Procedure
0.02 M	Weigh into a 100 ml volumetric flask 0.222 g anhydrous calcium chloride, dissolve and dilute to volume with distilled water.
0.025 M	(M/40) Weigh into a 100 ml volumetric flask 0.277 g anhydrous calcium chloride, dissolve and dilute to volume with distilled water.
0.03 M	Weigh into a 100 ml volumetric flask 0.332 g anhydrous calcium chloride, dissolve and dilute to volume with distilled water.
0.04 M	Weigh into a 100 ml volumetric flask 0.444 g anhydrous calcium chloride, dissolve and dilute to volume with distilled water.

8.3.3 Plasma and Serum Reagents

The following paragraphs describe various plasma and serum reagents used in coagulation testing. This list contains those items known to MLA at the time of printing, other products performing the same function may exist.

Adsorbed Plasma

Normal adsorbed plasma is a source of factors I, V, VIII, XI, and XII.

Aluminum Hydroxide Al(OH)$_3$ treated plasma

Pipette into a 13 x 100 mm test tube 1 ml of citrated plasma, add 0.1 ml aluminum hydroxide (Amphojel, Wyeth).

Mix and incubate the mixture in a 37°C water bath for 3 minutes.

Centrifuge the mixture at high speed for 10 minutes.

Carefully remove the supernatant plasma with a Pasteur Pipette.

The supernatant plasma must have a prothrombin time greater than 60 seconds. Repeat adsorption is necessary if the prothrombin time is less than 60 seconds.

Barium Sulfate BaSo$_4$ treated plasma

Pipette into a 13 x 100 mm test tube 1 ml of oxalated plasma, add 100 mg barium sulfate.

Place the plasma-barium sulfate mixture into a 37°C water bath for 15 minutes. Stir the mixture constantly.

Centrifuge the mixture at high speed for 10 minutes.

Carefully remove the supernatant plasma with a Pasteur pipette.

The supernatant plasma must have a prothrombin time greater than 60 seconds. Repeat adsorption is necessary if the prothrombin time is less than 60 seconds.

Aged Normal Serum

Normal aged serum is a source of factors VII, IX, X, XI and XII.

Place freshly drawn blood into a glass test tube and allow the blood to clot.

Place the tube into a 37°C water bath for 4 hours.

Following the 4 hour incubation period, centrifuge and remove the serum.

Place the serum into 37°C water bath for 24 hours.

Divide the serum into 1.0 ml portions and store in a −20°C freezer.

Sodium Chloride 0.85%

Weigh into a 100ml volumetric flask 0.85 g sodium chloride, dissolve and dilute to volume with distilled water.

Sodium Citrate 3.8%

Weigh into a 100 ml volumetric flask 3.8 g of sodium citrate (dihydrate), dissolve and dilute to volume with distilled water. Filter the solution and store in refrigerator.

Sodium Oxalate 0.1 M

Weigh into a 100 ml volumetric flask 1.34 g sodium oxalate, dissolve and dilute to volume with distilled water. Filter the solution and store in refrigerator.

Platelet Poor Plasma

Centrifuge anticoagulated whole blood at 1,000 rcf (g's) for 15 minutes.

Following centrifugation immediately remove the plasma.

Keep the plasma on ice or refrigerate 4-10°C until used.

Platelet Rich Plasma

Centrifuge anticoagulated whole blood at 500 rcf (g's) for 5 minutes.

Following centrifugation immediately remove the plasma.

Keep the Plasma on ice or refrigerate 4-10°C until used.

8.4 COAGULATION TEST PROTOCOLS

The procedures presented below provide the specific protocol for performing the indicated test. These procedures have been tested in our lab, and provide precise, accurate, and reproducible results. Good laboratory practice must exist to obtain good results.

Specific procedures for all clotting tests have not been provided due to the large number and variations of clotting tests. However, most tests are performed in a manner directly analagous to the common test procedures provided here. Additional material about these other tests may be obtained directly from MLA.

8.4.1 Prothrombin Time (PT) Test

Principle - In this test, clotting is initiated by adding tissue thromboplastin and calcium to plasma. This test activates Stage 2 and 3 in the extrinsic clotting system. The Prothrombin Time Test is most commonly used to monitor patients on anti-coagulant therapy, because it is sensitive to factors VII and X. Normal clot time is usually from 10 to 13 seconds. Patients on oral anti-coagulant therapy are usually medicated so that the PT is 2 - 2 1/2 times normal.

Material Required:

Electra 750
0.2 ml instrument pipette
0.1 ml pipette MLA #1055
Pipette tips – MLA # 9620
Test Cuvettes – MLA #9005
Stopwatch

Reagents Required:

Thromboplastin
Control plasma or fresh normal pool

Test Procedure

a) Turn on Electra 750. Perform abbreviated O.C.T. as given in paragraph 5.3.
b) Prior to initiating test, allow a 5 minute warmup period, or wait until AT TEMP indicator lights, which ever is longer.
c) Check that LAMP LEVEL switch is in "B" (middle position).
d) Reconstitute reagents and controls per manufacturer's instruction.
e) Pre-warm thromboplastin in REAGENT reservoir. Use magnetic stirring bar for reagents that require agitation (e.g. General Diagnostics Simplastin).
f) Set Mode Switch to PT.
g) Pipette 0.1 ml of controls and patient plasma, in duplicate, into the bottom of test cuvettes and place in rack.
h) Place first sample in heat block station #1 and start stopwatch.
i) After 30 seconds, place next sample in heater block station #2.
j) Continue in this manner adding next tube to heating block every 30 seconds.
k) After 3 minutes (180 seconds) take sample from heating station #1 and place it in test station.
l) Using 0.2 ml (red top) instrument pipette, aspirate 0.2 ml of warm thromboplastin and align pipette over test station. Firmly push pipette plunger and hold it down for one second to start test.
m) When timer stops, record clot time.
n) Continue in this manner, adding new sample to heating block and then start test every 30 seconds.
o) Use clean pipette tip on instrument pipette for each test to prevent carry over contamination.

NOTE

Using good technique, the instrument can be expected to achieve, for the PT test, an average coefficient of variation of 0.75%.

8.4.2 Prothrombin Activity Curve

Principle: - Oral anti-coagulant therapy can be monitored by a Prothrombin Time Test as a screening test for indication of possible deficiencies in factors VII and X. Any prolongation of the time required to form fibrin indicates that one or more of these factors is present in less than normal concentration. The reduction of activity to 10 - 30 percent of normal activity is considered the therapeutic range.

The curve is prepared by obtaining clot times from a saline dilution. The times are plotted on graph paper with Cartesian coordinates in which the prothrombin time in seconds is the vertical axis and the percent dilution is on the horizontal axis (Figure 8 - 1). The construction of this curve permits interpretation of any prothrombin times obtained with the particular sample of thromboplastin which was used to develop the curve.

A new curve should be prepared with a change in reagent, change in lot number, and periodically (six months). Checks of the system should be made on a daily basis, using both normal and abnormal controls.

Material Required

Electra 750
0.2 ml Instrument Pipette
0.1 ml MLA Pipette – MLA #1055
Pipette Tips, disposable – MLA #9620
Test Cuvettes – MLA #9005
Stopwatch
Graph paper
Test Tube Rack

Reagents Required

Thromboplastin
Normal Control Plasma or fresh normal pool
0.85% Normal Buffered Saline Solution

Preparation Of Dilutions

Two common procedures used in the preparation of dilutions are included here to provide (A) 100%, 50%, 25%, 12½%, and (B) 100% down to 20% in 10% increments.

Procedure A – for 100%, 50%, 25%, and 12½% test specimens. To obtain the above dilutions perform the following steps:

a) Place 0.1 ml of "normal" plasma in each of two cuvettes; this is 100% sample.

b) Place 0.5 ml of "normal" plasma in a cuvette and add 0.5 ml of 0.85% saline solution. Mix well but avoid excessive action that will aerate specimen. This is your 50% specimen. Extract two 0.1 ml specimens for your test samples.

c) Place 0.5 ml of 50% specimen of Step b) in fresh cuvette. Add 0.5 ml of 0.85% saline solution. Mix well, but avoid aeration. This is your 25% specimen. Extract two 0.1 ml specimens for your test specimen.

d) Place 0.5 ml of 25% specimen prepared in Step c) into fresh cuvette and add 0.5 ml of 0.85% saline solution. Mix well but avoid aeration. This is your 12½% specimen. Extract two 0.1 ml specimens for your test sample.

Assemble each of dilutions and run your test according to test procedure.

Procedure B – for 100%, 90%, 80%, 70%, 60%, 50%, 40%, 30%, 20% and 10% test specimens.

a) Take nine fresh cuvettes and place them in test tube rack. Place 1.0 ml of plasma into test tube #1, 0.9 ml of plasma into test tube #2, progressively reducing plasma by 0.1 ml until you have nine specimens ranging from 1.0 to 0.2 ml, as shown below.

Test Tube	1	2	3	4	5	6	7	8	9	10
Plasma (ml)	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
Saline (ml)	–	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Dilution	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%

b) Insert 0.1 ml of 0.85% saline solution into test tube #2, progressively increasing the saline solution by 0.1 ml until you have nine specimens ranging from 100% to 10%, as shown above.

c) Extract at least two 0.1 ml specimens from each of above dilutions to prepare your test specimens for running your Saline Dilution Test.

Test Procedure

The Prothrombin Activity Curve is generated by performing a PT test in duplicate on each of the diluted samples. The clot times are then plotted on graph paper using cartesian coordinates as shown in Figure 8 - 1.

Follow the PT test procedure as given in paragraph 8.4.1 with the following exception. Set Mode selector to SPEC. 1. In this position the instrument has extra sensitivity and can therefore detect clots with very low activity.

Interpretation of Test Results

In order to report percent activity of a patient plasma, a PT test is run according to the procedure in paragraph 8.4.1. The clot time reported is then found on the vertical axis and the corresponding percent activity is read from the horizontal axis.

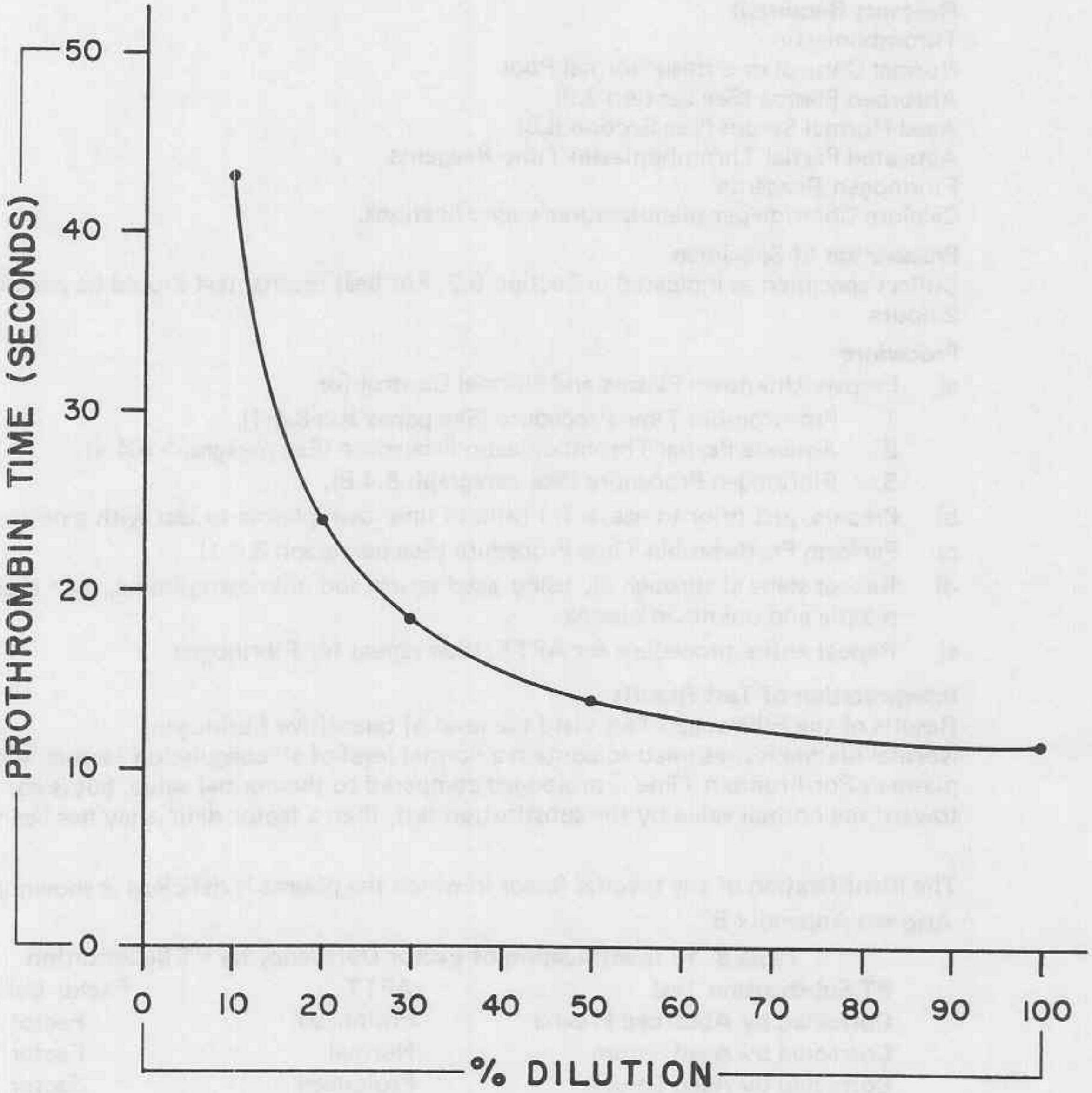


Figure 8-1 Saline Dilution Curve

8.4.3 PT Factor Substitution Test

Principle – The Prothrombin Time test is sensitive to plasma clotting factors I, II, V, VII, & X. Prolongation of the Prothrombin time is usually caused by a decreased concentration of a specific procoagulant. Through the substitution of reagents containing specific procoagulants and known deficient plasmas, the identification of the deficient procoagulant is possible.
The Activated Partial Thromboplastin Time test and Fibrinogen Assay, should be performed on all plasmas studied with the substitution test. The Prothrombin Time, the Activated Partial Thromboplastin Time, and Fibrinogen, are necessary for identification of the clotting factor deficiency.

Material Required:
Electra 750
0.2 ml instrument pipette
0.1 ml Pipette – MLA #1055
Pipette Tips – MLA #9620
Test Cuvettes – MLA #9005
Stopwatch

Reagents Required:
Thromboplastin
Normal Control or a fresh Normal Pool
Absorbed Plasma (See Section 8.3)
Aged Normal Serum (See Section 8.3)
Activated Partial Thromboplastin Time Reagents
Fibrinogen Reagents
Calcium Chloride per manufacturer's specifications.

Preparation of Specimen
Collect specimen as indicated in Section 8.2. For best results, test should be performed within 2 hours.

Procedure
a) Prepare Unknown Plasma and Normal Control for
  1. Prothrombin Time Procedure (See paragraph 8.4.1).
  2. Activate Partial Thromboplastin Procedure (See paragraph 8.4.4).
  3. Fibrinogen Procedure (See paragraph 8.4.8).
b) Prepare, just prior to use, a 1:1 ratio of unknown plasma to test with a normal control.
c) Perform Prothrombin Time Procedure (See paragraph 8.4.1).
d) Repeat steps a) through c), using aged serum and unknown plasma, then absorbed plasma and unknown plasma.
e) Repeat entire procedure for APTT, then repeat for Fibrinogen.

Interpretation of Test Results
Results of the Fibrinogen Test yield the level of quantitive fibrinogen.
Normal plasma is presumed to contain a normal level of all coagulation factors. When the test plasma's Porthrombin Time is prolonged compared to the normal value, but is corrected toward the normal value by the substitution test, then a factor deficiency has been established.

The identification of the specific factor in which the plasma is deficient is shown in Table 8 - 1. Also see Appendix B.

Table 8 -1. Identification of Factor Deficiency by PT Substitution

PT Substitution Test	APTT	Factor Deficient
Corrected by Absorbed Plasma	Prolonged	Factor V
Corrected by Aged Serum	Normal	Factor VII
Corrected by Aged Serum	Prolonged	Factor X
Not Corrected	Prolonged	Factor II

8.4.4 Activated Partial Thromboplastin Time (APTT) Test

Principle — The Activated Partial Thromboplastin Time test is a screening test for the intrinsic coagulation system. This test is sensitive to all the coagulation factors, with the exception of factors VII, XIII & Platelets. A reagent is added to the plasma which takes the place of the platelets in starting the coagulation mechanism. The activation time and temperature must be well controlled for proper activation to take place. Calcium is then added to trigger the coagulation, by providing the ions required.

The normal clot time for the Activated Partial Thromboplastin Time varies considerably with the particular reagent used. In general, the normal time is from 24 to 45 seconds.

Material Required:

Electra 750
0.1 ml Instrument Pipette
0.1 ml Pipette, MLA #1055
Pipette Tips, disposable, MLA #9620
Test Cuvettes – MLA #9005
Stopwatch
Test Tube Rack

Reagents Required

APTT Reagent
Normal Control or fresh normal pool
Calcium Chloride - .02 M or .025 M depending upon the reagents used.

Test Procedure

a) Turn on Electra 750, warm up instrument for five minutes or until AT TEMP lights, whichever is later. Perform the abbreviated Operator Confidence Test in paragraph 5.3.
b) Reconstitute reagents and controls per manufacturer's instructions.
c) Prewarm Calcium Chloride in calcium reservoir.
d) For ellagic acid type reagent, set mode switch to APTT. For Particulate type activator materials, set mode switch to SPEC 2.

NOTE

> At time of printing, common ellagic acid activators are Dade Cephaloplastin or Actin, and Ortho Thrombofax. A common type of particulate activator is General Diagnostic's Platelin Plus, or Automated APTT reagent.

e) In a separate rack, pipette 0.1 ml of activator into MLA test cuvette. Number cuvettes. Test all samples in duplicate.
f) Add to the first tube, 0.1 ml of the first plasma sample, shake and place in heating block station #1, then start stopwatch.
g) After 100 seconds, add 0.1 ml plasma to the next cuvette with activator. Shake and place in heater station #2.
h) Continue in this manner, adding tube to heater block every 100 seconds.
i) After 300 seconds (5 minutes) take sample #1 from heating station #1 and place it in test station.
j) Using 0.1 ml blue top instrument pipette, aspirate 0.1 ml of calcium and align pipette over test station. Firmly push pipette plunger and hold it down for one second to start the test.
k) When timer stops, record clot time.
l) Continue in this manner, adding sample to heating block, and then starting test every 100 seconds.

NOTE

Precise control of incubation time is essential for good results in the APTT test. Significant deviations from the specified activation time will reduce the reproducibility of the test.

Interpretation of Test Results

The APTT time should be reported in conjunction with the normal range. The normal range varies considerably depending upon the particular reagent and laboratory techniques used. Therefore, normal range must be determined for each laboratory.

Prolongation of the APTT indicates an abnormality in one of the clotting factors affecting this test or the presence of anticoagulants such as heparin. For identification of particular coagulation factor deficiencies, Factor Substitution and Assay tests should be performed. (See paragraph 8.4.5) Using good techniques with the APTT test, the user is expected to achieve an average coefficient of variation of 1.3%.

8.4.5 APTT Factor Substitution Test

Principle

The activated Partial Thromboplastin Time is essentially a control test for all clotting factors, except Factors VII & XIII. A prolongation of the Activated Partial Thromboplastin Time is usually caused by a decrease in concentration of a specific procoagulant. Identification of a deficient procoagulant is possible through the APTT Factor Substitution Test containing specific procoagulants and known deficient plasmas.

A Prothrombin Time should be performed on all plasmas studied with the substitution test. Both the Partial Thromboplastin Time and the Prothrombin Time are necessary for identification of the deficient coagulation factor.

Materials Required

Electra 750
0.1 ml Instrument Pipette
0.1 ml Pipette, MLA #1055
Pipette tips, disposable, MLA #9620
Test Cuvettes - MLA #9005
Stopwatch
Test Tube Rack

Reagents Required

Activated Partial Thromboplastin Reagents (paragraph 8.4.4) Calcium Chloride (consult manufacturer's literature)
Absorbed Normal Plasma
Aged normal serum
Normal control plasma or a fresh normal pool
Prothrombin Time Reagents (paragraph 8.4.1)

Preparation of Specimen

Collect specimen in accordance with paragraph 8.2.

Test Procedure

a) Perform Prothrombin Time test (paragraph 8.4.1) on unknown plasma.
b) Perform Activated Partial Thromboplastin Time test (paragraph 8.4.4) for a normal control plasma and unknown plasma.
c) Just before use, prepare 1:1 ratio of unknown plasma and normal plasma.
d) Perform APTT test (paragraph 8.4.4).
e) Repeat steps c) & d) for a 1:1 ratio of aged normal serum and unknown plasma; repeat again for a 1:1 ratio of absorbed normal plasma and unknown plasma.

Interpretation of Test Results

Normal plasma is presumed to contain a normal level of all clotting factors. A prolongation caused by a factor deficiency will show a correction toward the normal range when a normal plasma is mixed with a factor deficient plasma.

The results obtained using aged normal serum, absorbed normal plasma and the prothrombin time, will determine the factor deficiency of the plasma. Refer to Table 8-2 and Appendix B.

Table 8 -2. Identification of Factor Deficiency by APTT Substitution

APTT Substitution Test	Prothrombin Time	Factor Deficient
Corrected by absorbed plasma	Prolonged	V
Corrected by absorbed plasma	normal	VIII
Corrected by aged serum	normal	IX
Corrected by aged serum	prolonged	X
Corrected by absorbed plasma and aged serum	normal	XI
Corrected by absorbed plasma and aged serum	normal	XII

8.4.6 Factor VIII & IX Assays

Principle – the level of Factor VIII or Factor IX is determined by a substitution assay test, which measures the corrective effect on the APTT time obtained when the test plasma is added to a severe factor deficient substrate plasma. By comparing the results obtained with the test plasma to results produced by known concentrations of Factor VII or Factor IX, the percentage of the Factor present can be determined. Normal plasma is considered to give 100% correction.

To obtain accurate, reproducible results, use a standard APTT activation time. A new calibration curve must be made when there is a change in the lot number of reagents and/or a change in collection system.

Factor VII and Factor IX assays are performed in exactly the same manner, except the corresponding Factor deficient substrate is used.

Materials Required

Electra 750 0.1 ml
0.1 ml Instrument Pipette
0.5 ml Pipette
1.0 ml Pipette
2 cycle log-log graph paper
Pipette Tips disposable, MLA #9620
Test Cuvettes, MLA #9005
Stopwatch
Test Tube Rack

Reagents Required

Activated Platelet Substitute Reagent
Calcium Chloride (consult reagent manufacturer's literature)
0.85% Buffered Saline Solution
Normal Plasma. Either Normal citrate control plasma or a fresh normal pool (citrate collected)
Factor deficient substrate plasma

Test Procedure

Collection of unknown plasma:
Collect specimen in accordance with paragraph 8.2.
Specimens collected for this test must be tested within 2 hours of being drawn.
Calibration Curve:

a) Pipette 0.8 ml of buffered diluent into tube #1 and 0.5 ml of diluent into tubes #2 through #7.

b) Pipette 0.2 ml of normal plasma into the first tube and mix well.

c) Transfer 0.5 ml from tube #1 into tube #2 and mix well. Continue through tube #7 as shown in the example.

Example

	1	2	3	4	5	6	7
Buffered Diluent (ml)	0.8	0.5	0.5	0.5	0.5	0.5	0.5
Normal Plasma (ml)	0.2	–	–	–	–	–	–
Mix and Transfer		0.5	0.5	0.5	0.5	0.5	0.5
Dilution	1:5	1:10	1:20	1:40	1:80	1:160	1:320
% of Factor Present	100	50	25	12½	6.25	3.13	1.5

d) Prepare sufficient quantity of factor deficient plasma and pool to run the required tests.

e) Dispense into each of two cuvettes, 0.1 ml of 1:5 dilution, 0.1 ml of factor deficient plasma, and 0.1 ml of activating reagent. Mix and place into heating block.

f) Perform APTT test on plasma in accordance with procedure of paragraph 8.4.4.

g) Repeat steps e) and f) for each level of dilution.

h) Average duplicate results, and plot on cycle log-log graph paper with percent of dilution on horizontal axis, and time in seconds on vertical axis.
Connected points should approximate a straight line.
(See typical curve in Figure 8 -2 and 8 -3.)

Unknown Plasma

a) To test unknown plasma, make 1:5 dilution of plasma using buffered saline.

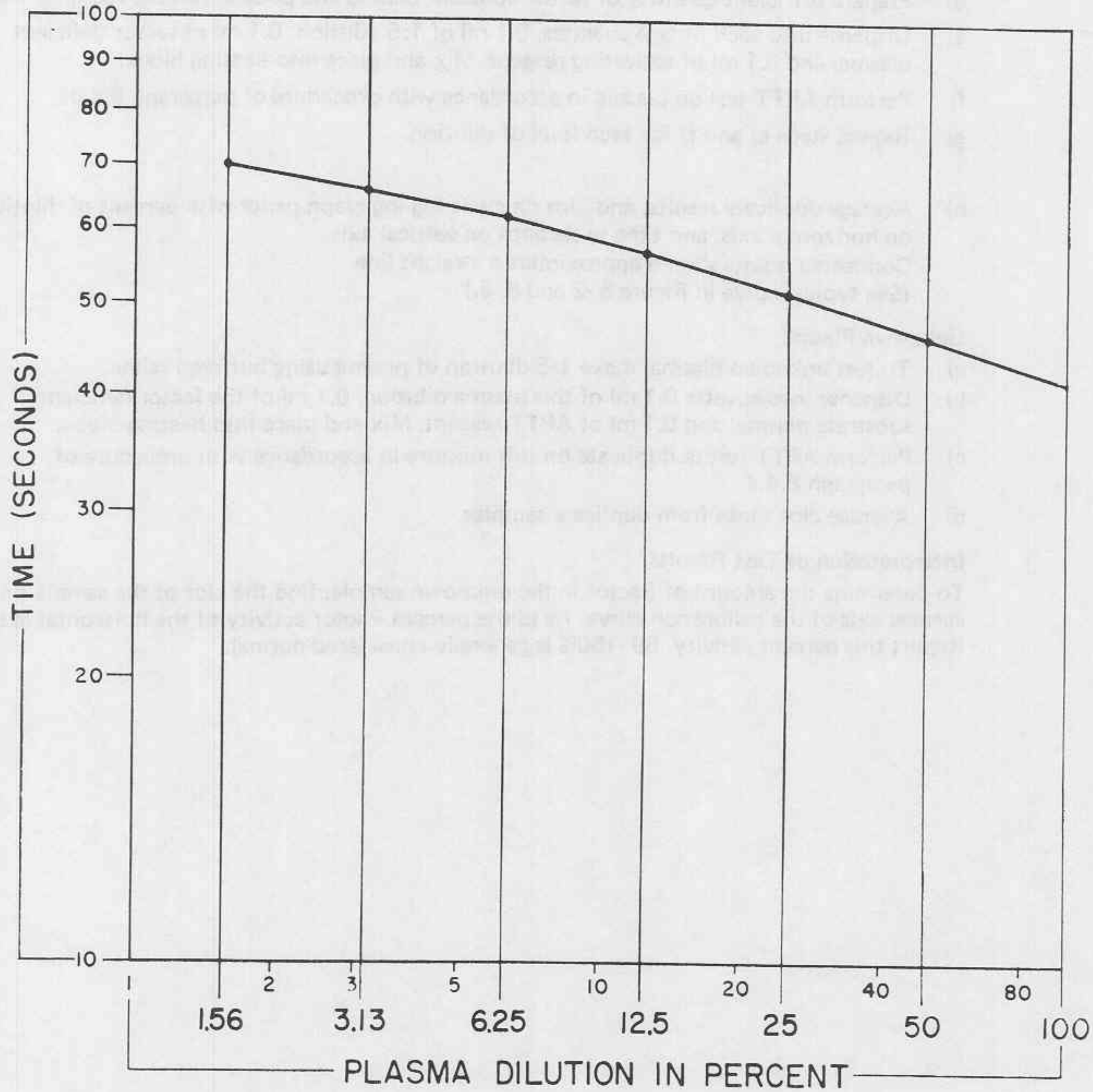
b) Dispense into cuvette 0.1 ml of this plasma dilution, 0.1 ml of the factor deficient substrate plasma, and 0.1 ml of APTT reagent. Mix and place into heating block.

c) Perform APTT test in duplicate on this mixture in accordance with procedure of paragraph 8.4.4.

d) Average clot times from duplicate samples.

Interpretation of Test Results

To determine the amount of Factor in the unknown sample, find the clot of the sample on the vertical axis of the calibration curve. Read the percent Factor activity of the horizontal axis. Report this percent activity. 50 -150% is generally considered normal.



326144-12

Figure 8-2 Typical Factor VIII Assay Curve

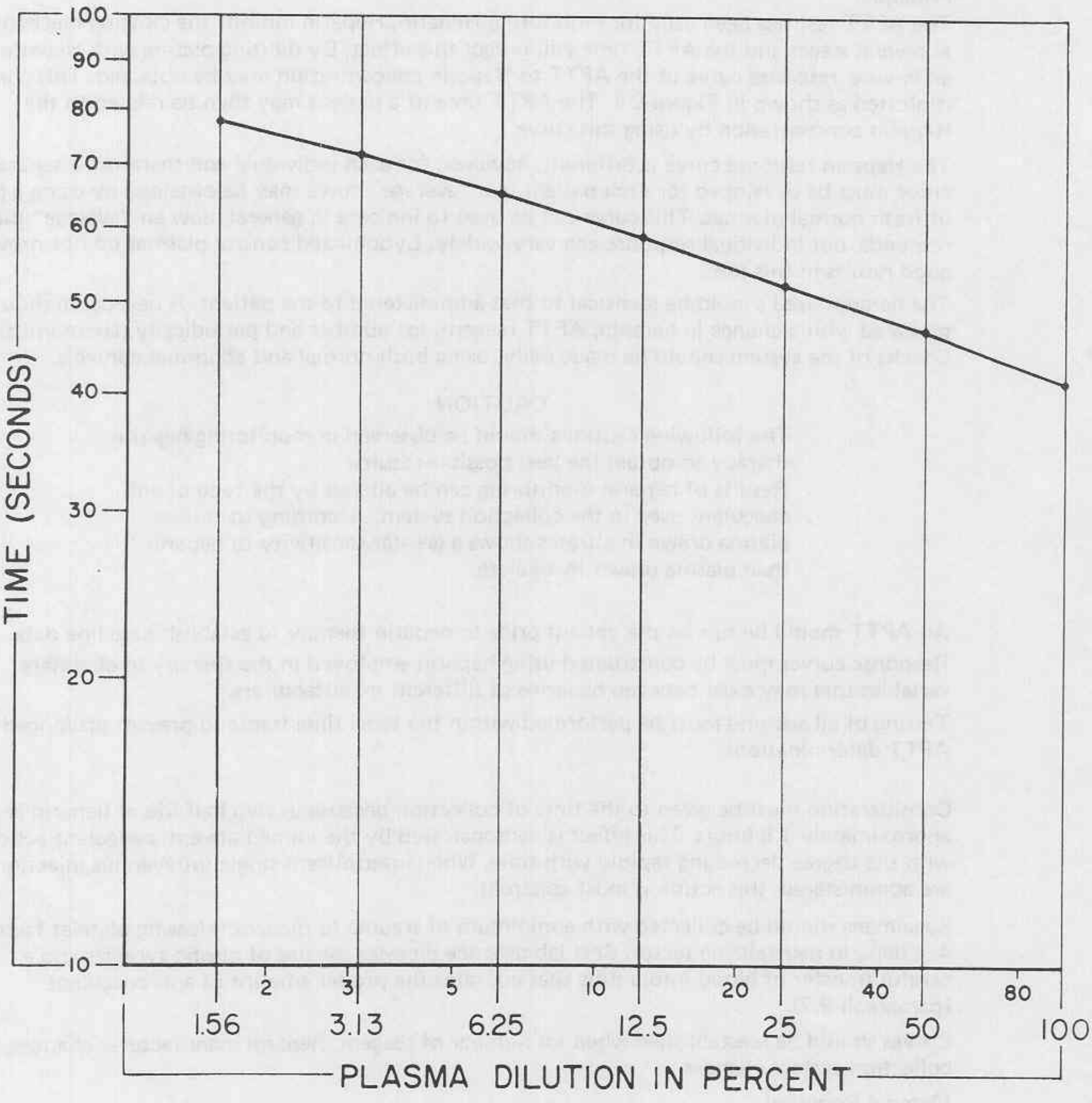


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Figure 8-3 Typical Factor IX Assay Curve

8.4.7 Heparin Assay Using the APTT

Principle:

The APTT test has been used for monitoring Heparin. Heparin inhibits the clotting mechanism at several stages and the APTT time will reflect this effect. By diluting plasma with Heparin, an *in-vitro* response curve of the APTT to Heparin concentration may be obtained. This curve is plotted as shown in Figure 8-4. The APTT time of a patient may then be related to the Heparin concentration by using this curve.

The Heparin response curve is different, however, for each individual and therefore a separate curve must be developed for each patient. An "average" curve may be obtained by using a pool of fresh normal plasmas. This curve can be used to indicate in general, how an "average" plasma responds, but individual response can vary widely. Lyophilized control plasmas do not provide good results in this test.

The herapin used should be identical to that administered to the patient. A new curve should be prepared with a change in herapin, APTT reagent, lot number and periodically (six months). Checks of the system should be made daily, using both normal and abnormal controls.

CAUTION

> The following cautions should be observed in monitoring heparin therapy to obtain the best possible results.
> Results of heparin monitoring can be altered by the type of anti-coagulant used in the collection system. According to studies, plasma drawn in citrates shows a greater sensitivity to heparin than plasma drawn in oxalate.

An APTT should be run on the patient prior to heparin therapy to establish base line data.

Response curves must be constructed using heparin employed in the therapy to eliminate variables that may exist between heparins of different manufacturers.

Testing of all samples must be performed within the same time frame to prevent prolonged APTT determinations.

Consideration must be given to the time of collection because in vivo half life of heparin is approximately 1.5 hours. This effect is demonstrated by the immediate anti-coagulant action, with the degree decreasing rapidly with time. When intermittent single intravenous injections are administered, this action is most apparent.

Specimens should be collected with a minimum of trauma to prevent releasing platelet factor 4, a heparin neutralizing factor. Best lab practice dictates the use of plastic syringes and a careful transfer of blood into a tube that contains the proper amount of anti-coagulant (paragraph 8.2).

Curves should be reestablished when lot number of reagent, heparin manufacturer changes, or collection system changes.

Material Required

Electra 750
0.1 ml Instrument Pipette
0.1 ml Pipette, MLA #1055
Disposable Pipette Tips, MLA #9620
Test Cuvettes, MLA #9005
Stopwatch
Semi-log Graph Paper
Test Tube Rack

Reagents Required

APTT Reagent

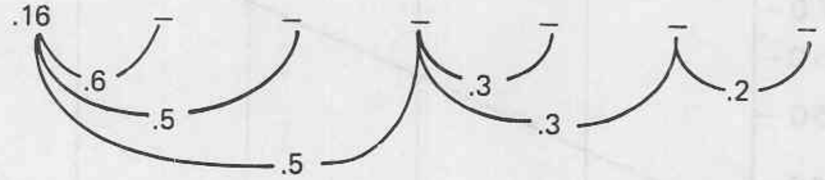
Fresh normal pool or patient plasma, prior to herapin therapy.
Calcium Chloride, .02 M or .025 M depending on reagent used
Heparin used in patient therapy
0.85% Saline Solution

Preparation of Heparin Assay Curve

Heparin is generally available in 1000 units/ml injectable doses. This type requires a 1:100 dilution with 0.85% saline for preparation of a stock working heparin solution of 10 units/ml. The heparin label should be consulted for proper dilution.

a) Prepare dilutions using patient plasma before therapy or normal pool plasma in the following concentrations – 0.8, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1 units/ml as follows:

Tube	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Normal Plasma (ml)	1.84	0.2	0.3	0.5	0.1	0.3	0.2
Heparin (10U/ml)	.16	–	–	–	–	–	–
Mix & Transfer							
Heparin Concentration	0.8	0.6	0.5	0.4	0.3	0.2	0.1



b) Place seven tubes in test tube rack.

c) Add 1.84 ml of normal plasma to test tube #1.

d) Add 0.16 ml of heparin solution to test tube #1 and shake gently. This is 0.8 units/ml solution.

e) Using pipette, aspirate 0.6 ml of solution from tube #1 and dispense into tube #2.

f) Add 0.2 ml of normal plasma to tube #2 and shake gently. This is 0.6 units/ml solution.

g) Using pipette, aspirate 0.5 ml of solution from tube #1 and dispense into tube #3.

h) Add 0.3 ml of normal plasma to tube #3 and shake gently. This is 0.5 units/ml solution.

i) Using pipette, aspirate 0.5 ml of solution from tube #1 and dispense into tube #4.

j) Add 0.5 ml of normal plasma to tube #4 and shake gently. This is 0.4 units/ml solution.

k) Using pipette, aspirate 0.3 ml of solution from tube #4 and dispense into tube #5.

l) Add 0.1 ml of normal plasma to tube #5 and shake gently. This is 0.3 units/ml solution.

m) Using pipette, aspirate 0.3 ml of solution from tube #4 and dispense into tube #6.

n) Add 0.3 ml of normal plasma to tube #6 and shake gently. This is 0.2 units/ml solution.

o) Using pipette, aspirate 0.2 ml of solution from tube #6 and dispense into tube #7.

p) Add 0.2 ml of normal plasma to tube #7 and shake gently. This is 0.1 units/ml solution.

Test Procedure – Assay Curve

a) Perform APTT procedure (paragraph 8.4.4) in duplicate on each sample.

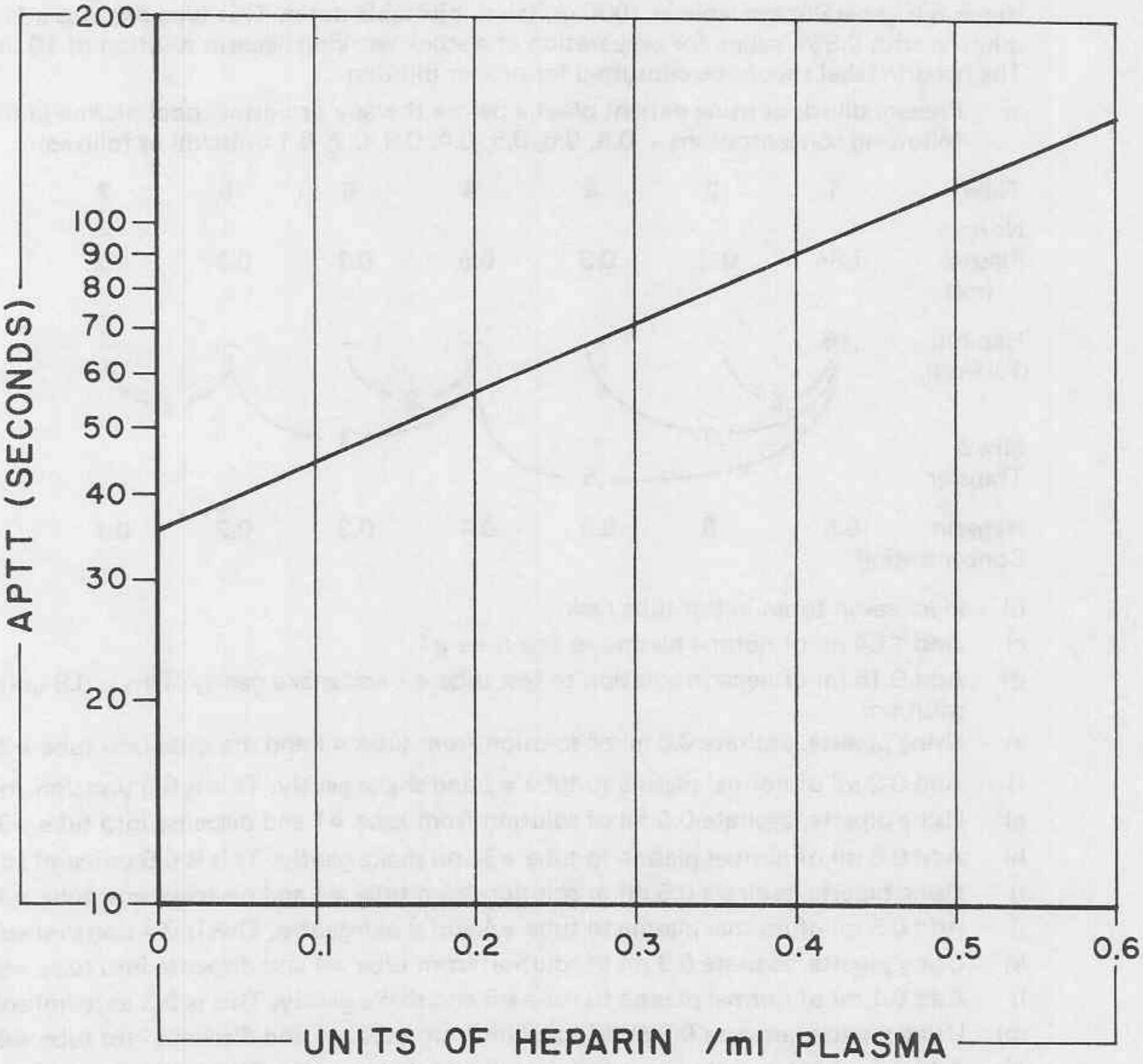
b) Using semi-log graph paper, plot APTT time for each specimen on vertical axis and concentration on horizontal axis. Connect points plotted on graph. This is the response curve. (See Figure 8 - 4.)

Test Procedure – Patient

a) Perform APTT procedure (paragraph 8.4.4) in duplicate on heparinized patient plasma.

Interpretation of Test Results

The heparin concentration of the patient plasma is determined by locating the patient's clot time on the vertical axis of the heparin assay curve and then reading the corresponding heparin concentration from the horizontal axis. As described above, ideally the heparin curve should be derived from the patient plasma.



326144-14

Figure 8-4 Typical Heperin Response Curve

8.4.8 Quantitative Fibrinogen Assay Using Dade Fibrinogen Determination Kit

Principle:

The Thrombin clotting time of dilute plasma is inversely proportional to the fibrinogen consideration of the plasma, provided the thrombin concentration is high and the fibrinogen concentration is fairly low (5-80 mg/dl). In this test, the amount of fibrinogen in a plasma sample is determined by its thrombin clotting time of the diluted plasma to that of a standard plasma of known fibrinogen content.

The Electra 750 is capable of detecting fibrinogen concentrations as low as 10-14 mg/dl. Normal concentrations in plasma are from 200-400 mg/dl.

This procedure is specifically written to be used with the Dade Fibrinogen Determination Kit. While other kits are available, at the time of printing this is the most widely used kit. Procedures for other kits are similar.

CAUTION

Fibrinogen Assays can be performed on only sodium citrate collection systems.

Preparation of the Fibrinogen Standard Curve

CAUTION

The standard curve must be repeated whenever a different lot number of Thrombin Reagent is used. It should also be done periodically to insure no changes in the curve takes place.

Materials Required

Electra 750
0.1 ml pipette MLA #1055
0.2 ml instrument pipette
0.5 ml pipette
1.0 ml pipette
2 cycle log-log Graph paper - MLA #9041 or equivalent
Test Tube Rack

Reagents Required

Dade Thrombin Reagent
Dade Fibrinogen Calibration Reference
Owrens Veronal Buffer

Preparation of Fibrinogen Dilutions Based on Assay Value

Check the assay value of the Fibrinogen Reference Plasma.

Perform the dilution procedure indicated in Table 8 -3.

Table 8 -3. Dilutions for Ranges of Fibrinogen Assay Values.

Fibrinogen Reference Assay Value	Procedure	Dilution
210 - 280	A	1/5, 1/10, 1/15
280 - 350	B	1/5, 1/10, 1/20
350 - 450	C	1/10, 1/20, 1/25

Procedure A:

Preparation of Fibrinogen Standard Dilutions - 1/5, 1/10, 1/15.

a) Place 1.6 ml of Owren's Veronal Buffer into a suitable cuvette.
b) Add 0.4 ml of Fibrinogen Standard. Mix thoroughly, taking care not to cause aeration of sample. This cuvette contains 1/5 dilution.
c) Extract 0.5 ml of 1/5 specimen prepared in step b above, and place in second cuvette.
d) Add 0.5 ml of Owren's Veronal Buffer to second cuvette and mix thoroughly, avoid aeration. This second cuvette contains 1/10 dilution.
e) Extract 0.4 ml of 1/5 specimen prepared in step b) above, and place in third cuvette.
f) Add 0.8 ml of Owren's Veronal Buffer to third cuvette and mix thoroughly, avoid aeration. This third cuvette contains the 1/15 dilution.

Procedure B

Preparation of the Fibrinogen Standard Dilutions - 1/5, 1/10, 1/20

a) Place 1.6 Owren's Veronal Buffer into a suitable cuvette.
b) Add 0.4 ml of Fibrinogen Standard. Mix thoroughly, taking care not to cause aeration of the sample. This cuvette contains the 1/5 dilution.
c) Extract 0.5 ml of the specimen prepared in step b) aboce, and place in second cuvette.
d) Add 0.5 ml of Owren's Veronal Buffer to second cuvette and mix thoroughly, avoid aeration. This second cuvette contains 1/10 dilution.
e) Extract 0.4 ml of 1/5 specimen prepared in step b) above, and place in third cuvette.
f) Add 1.2 ml of Owren's Veronal Buffer to third cuvette and mix thoroughly, avoid aeration. This third cuvette contains 1/20 dilution.

Procedure C:

Preparation of the Fibrinogen Standard Dilutions - 1/10, 1/20, 1/25

a) Place 1.8 ml of Owren's Veronal Buffer into suitable cuvette.
b) Add 0.2 ml of Fibrinogen Standard. Mix thoroughly, taking care not to cause aeration of sample. This cuvette contains 1/10 dilution.
c) Extract 0.5 ml of the 1/10 specimen prepared in step b) above, and place in second cuvette.
d) Add 0.5 ml of Owren's Veronal Buffer to second cuvette and mix thoroughly, avoid aeration. This second cuvette contains 1/20 dilution.
e) Extract 0.4 ml of 1/10 specimen prepared in step b) above, and place in third cuvette.
f) Add 0.6 ml of Owren's Veronal Buffer to third cuvette and mix thoroughly, avoid aeration. This third cuvette contains 1/25 dilution.

Fibrinogen Test Procedure

a) Reconstitute reference plasma and prepare dilutions in accordance with Table 8 - 3 and the appropriate procedure
b) Reconstitute Thrombin Reagent

CAUTION

DO NOT WARM THROMBIN REAGENT

c) Perform abbreviated O.C.T. (paragraph 5 - 3).
d) Set Mode Switch to Thrombin and Lamp Level to B
e) Pipette 0.2 ml of plasma into cuvettes.

NOTE

Run all tests in triplicate

f) Place first specimen in incubation station No. 1 and start stopwatch.

g) After 30 seconds place next sample in incubation station No. 2 and continue in this manner adding next tube every 30 seconds.

h) After 3 minutes, place sample No. 1 into test well.

i) Using 0.1 ml (blue top) instrument pipette, aspirate 0.1 ml of Thrombin reagent and align pipette over test station. Firmly push plunger and hold down for one second to start test.

j) When timer stops, record clot time.

k) Continue in this manner, adding new sample to incubation station after each test.

l) Use clean pipette tip on instrument pipette for each test to prevent carry over contamination.

Plotting Calibration Curve

The Fibrinogen Calibration curve is plotted on log-log graph paper. The curve on the package insert provided with the kit may be used. However, the graph paper supplied by MLA is better suited for the Electra 750.

Plot the calibration curve by performing the following steps:

a) Average triplicate clot times obtained for each dilution level.

b) Determine equivalent fibrinogen values for each dilution as follows: The Assay value of the Fibrinogen reference plasma is assigned to 1:10 dilution level. The values of the dilutions are determined by multiplying the assay value by the factor given in Table 8 - 4.

Table 8 – 4: Dilution Multiplying Factor For Fibrinogen Curve

Dilution	Factor
1:5	2
1:10	1
1:15	0.67
1:20	0.5
1:25	0.4

c) Plot fibrinogen level versus averaged times, using ordinate for time and abscissa fibrinogen level.

d) Draw best straight line through plotted points.

Example:

Fibrinogen Reference FS–15 has an assay value of 229 mg/dl. Plasma in diluted in accordance with Table 8 - 3. In this case, the assay value requires dilutions of 1:5, 1:10, and 1:15. Using Table 8 - 4, the Fibrinogen level is as follows:

Dilution	Multiply	Fibrinogen Value
1:5	2	2 x 229 = 458
1:10	1	1 x 229 = 229
1:15	0.67	0.67 x 229 = 153

These values are then plotted with the respective clot times to permit construction of the curve shown in Figure 8 - 4.

Assay of Patient Plasma

Procedure and Interpretation of Test Results

a) A control plasma should be run to check the system, if an old assay curve is being used. Dilute plasma 1:10 in Owren's Veronal Buffer and test in triplicate, just as a patient plasma. Compare manufacturer's assay value of control plasma to that predicted by test technique. The two values should agree within approximately ±15%. If poor agreement is found, prepare a new assay curve.

b) Dilute patient plasma and control 1:10 with Owren's Veronal Buffer (0.1 ml of plasma to 0.9 ml of Buffer).

c) Perform Fibrinogen test procedure steps b) through l).

NOTE

> If a clot is not detected, as evidenced by a continually running timer, fibrinigen value is probably very low. Perform step e) 2) below.

d) Determine fibrinogen assay value by locating average time of patient on vertical axis of assay curve (Figure 8 - 5), and read fibrinogen value on horizontal axis at point of intersection.

CAUTION

> Mistakes can be made easily in reading log-log graphs. Therefore, care should be exercised when reading the fibrinogen value on the curve.

e) Use center of calibration curve for most accurate results. When fibrinogen values are less than 130 mg/dl or greater than 700 mg/dl, dilutions should be prepared that will provide results in center of curve.

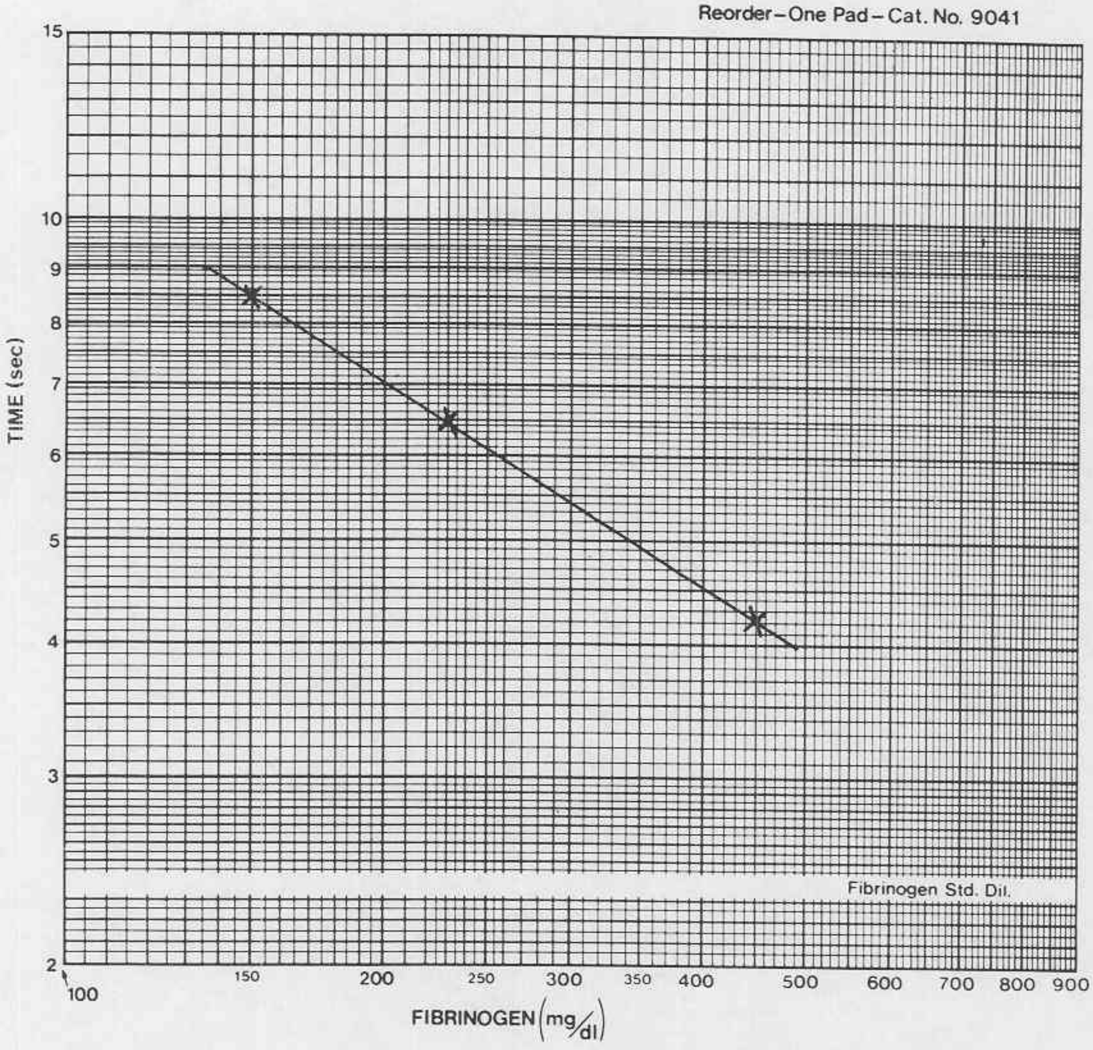
   1) When fibrinogen value is above 700 mg/dl, dilute patient plasma 1:20 (0.5 ml plasma to 0.95 ml Owren's Veronal Buffer) and rerun test. Multiply fibrinogen value predicted by assay curve by 2 to obtain true fibrinogen value.

   2) When fibrinogen value is below 130 mg/dl, dilute patient plasma 1:15 (0.1 ml plasma to 0.4 ml Owren's Veronal Buffer) and rerun test. Divide fibrinogen value by 2 to obtain true fibrinogen value.

MLA®

Fibrinogen Assay Graph Paper

Reorder – One Pad – Cat. No. 9041



NOTE; Use this graph only with: Fibrinogen Secondary Standard LOT No. ____________ mg/dl

Thrombin Time Curve for Fibrinogen Assay. Typical Curve for ELECTRA ______ S/N __________

MLA® Medical Laboratory Automation, Inc.
270 Marble Avenue, Pleasantville, New York 10570-2982

Figure 8-5 Typical Thrombin Time Curve for Fibrinogen Assay

SECTION 9

MAINTENANCE, DISASSEMBLY, AND REPAIR

9.1 INTRODUCTION

The maintenance and repair data included in this section is presented in two major categories: (1) preventive maintenance and (2) corrective maintenance. Under preventive maintenance, procedures for ensuring that the E750 is operating and will continue to operate properly are presented. Under corrective maintenance, procedures for disassembling the unit to remove specific assemblies are included. In addition, pipette accuracy measurement procedures are included.

9.2 PREVENTIVE MAINTENANCE PROCEDURES

The preventive maintenance procedure is performed to ensure that the instrument will continue to operate in accordance with factory specifications.

9.2.1 Cleaning

The workstation (Figure 4-3) of the E750 is subject to collection of foreign matter. Perform the following steps to clean the unit.

a. Prepare cleaning solution comprised of equal parts of distilled water and isopropyl alcohol.
b. Using clean lint-free cloth, apply cleaning solution to surface of unit and remove dried plasma and/or reagent.
c. Using cleaning solution and cotton swab, remove debris, dried plasma or reagent, and any other foreign matter from bottom of reservoir wells.
d. Check that test well is clean and free of debris. If not, use cleaning solution to clean after removing debris.
e. Remove fingerprints from readout panel using cleaning solution.
f. Check that any debris collected in covers is removed.
g. After all surfaces have been cleaned, apply light coat of spray wax to improve cosmetic appearance of painted surfaces.

9.2.2 Testing and Measurements

Perform the measurements and adjustments presented in Section 10 as a part of each preventive maintenance procedure.

9.2.3 Pipette Accuracy Measurements

As part of each preventive maintenance procedure measure the accuracy of the pipette provided with E750 by performing the following procedure.

Materials Required

A weighing device capable of reading to 0.5 mg.
Distilled water
Data sheet, (see Figure 9-1 and reproduce as required for tests)

NOTE

When making pipette accuracy measurements, MLA disposal tips must be used to insure operation in accordance with factory specifications.

a. Perform tests in accordance with pipetting techniques as outlined in Section 5.
b. Record weights as soon as possible to eliminate errors due to evaporation.
c. Complete headings of data sheet before starting test procedure.
d. Enter test data on sheets as indicated.
e. After five weighings have been completed, add five weighings to obtain sum of five sample weights. Divide by five; answer yields average sample weight. From average sample weight subtract pipette size in lambdas.

DATA SHEET FOR ACCURACY ONLY

SIZE________________Lambda INITIALS____________ DATE_______________

ACCURACY ______%

SAMPLE NO.	SAMPLE WT. IN MILLIGRAMS
1	
2	
3	
4	
5	

Sum of sample weights (____________) = (___________________)
5 AVERAGE SAMPLE WT.

STEP 1 = Subtract pipette size in Lambdas from average sample weight.
(   ) AVERAGE SAMPLE WT.
— (   ) Pipette size in Lambdas
____
(   )

STEP 2 = Divide answer to STEP 1 by pipette size in Lambdas.
(   )
__________ = (   )
(   )

STEP 3 = Multiply answer to STEP 2 by 100.
(   ) X 100 = _______________%
ACCURACY

326158–43

Figure 9-1. Pipette Accuracy Data Sheet

f. Divide answer in preceeding steps by pipette size in lambdas. Multiply answer by 100, answer is accuracy of pipette in percent. Pipette accuracy must be within plus or minus 5% to satisfy factory specifications. If pipettes are beyond allowable limits, they must be returned to factory for recalibration.

9.3 Preventative Maintenance Checkout

This procedure must be performed at completion of each preventive maintenance or repair procedure to ensure that the instrument is functioning properly. If, during this checkout procedure, the instrument fails to achieve the expected result, it is not operating satisfactorily, and you should refer to Section 7 Troubleshooting to determine the cause of the malfunction.

a. Connect E750 to power source. See paragraph 4.2

b. Turn unit on by operating power switch to ON. Check that digital display reads "0".

c. Reomve test cuvette (if any) from test station. Press INCUBATION TIMER switch. Check that digital display counts. Press INCUBATION TIMER switch again and check that digital display resets to "0".

d. Restart Incubation timer by pressing INCUBATION TIMER button and, while it is timing, place test cuvette in test well. Check that timer resets to zero and when INCUBATION TIMER is pressed timer does not operate unless cuvette is removed from test station.

e. Obtain stopwatch. Simultaneously press INCUBATION TIMER and start stopwatch. Check times on both E750 and stopwatch after 60 seconds to see that timer agree. If stopwatch and timer disagree, proceed to troubleshooting, Section 7.

f. Place empty test cuvette into test station and place either instrument pipette over test cuvette.

g. Set LAMP LEVEL switch, on rear panel, to A (up position). Set Mode switch to PT.

h. Press pipette plunger and observe digital display. Check that timer counts to 7.0 seconds, then, resets to zero. Check that OFF SCALE indicator then lights.

i. Remove cuvette from test station and check that OFF SCALE indicator goes off.

j. Replace tube and repeat step (h) for each of five mode settings. Time at which display resets varies with mode setting. This time is guard interval. The following table provides guard interval for each Mode.

k. Set LAMP LEVEL switch to "C" position (down position). Set mode switch to APTT. Place dark cuvette, i.e. cuvette with paper stuffed in bottom to prevent light from being transmitted through cuvette to photocell, place in test well, and cover with instrument pipette.

l. Press pipette plunger to start timer. Check that timer counts to 16.0 seconds, then resets to zero and off-scale indicator then lights.

m. Remove cuvette from test station and check that off-scale indicator extinguishes.

n. Place empty cuvette into test station and cover with instrument pipette.

o. Press pipette plunger to start timer. While timer is running, operate LAMP LEVEL switch from "C" to "B" and back to "C" position. Check that timer stops after 16 seconds (guard interval). Prior to completion of guard interval, timer will not stop. Remove cuvette from test station. Check that timer does not reset. Reinsert cuvette into test station. Check that timer reset to zero.

p. Check that temperature on workstation thermometer reads 37.2°C±0.5°C.

q. Check that AT TEMP indicator has illuminated.

Preventive Maintenance Checklist

The checklist is provided as a convenient means of checking that all activities associated with preventive maintenance have been performed.

CLEANING
VOLTAGE CHECKS & ADJUSTMENTS
+ 12 VDC
– 12 VDC
+ 180 VDC
PIPETTE ACCURACY (Instrument)
PIPETTE ACCURACY (Non-instrument)
DIGITAL DISPLAY READ 0 WHEN UNIT IS TURNED ON
INCUBATION TIMER OPERATES
INCUBATION TIMER ACCURACY
GUARD INTERVALS
OFF-SCALE INDICATOR
AT TEMP INDICATOR
TEMPERATURE

9.4 DISASSEMBLY

9.4.1 General Disassembly Procedures

The following procedures are General Disassembly Procedures that will be referred to in the following paragraphs in repairing or replacing specific items.

a. Remove all items from workstation, pipettes, cuvette, etc.

b. Remove six (6) screws, three (3) on each side in front portion of E750 top cover. Two (2) remaining screws, one (1) on each side, at rear of instrument should be loosended one full turn. This will allow top sheet metal cover to be rotated 90 degrees to open position using two (2) rear screws as hinges.

c. Remove two (2) screws at top of printed circuit board hold-down clamp (see Figure 7 - 5).

d. Slide instrument slightly forward on bench so as to have front portion sitting just beyond edge of bench. Loosen three (3) screws at bottom front sheet metal cover. Loosen two (2) thumb nuts in upper left and right-hand corners of front cover below display support bracket (see Figure 9 -2). Slide front cover forward until lip at bottom is beyond base plate and lift front cover off.

e. Disconnect heater block assembly from mother board by releasing two (2) retaining clips, one (1) on each end of the heater block's connector A2P7/A2J7 (see Figure 9 -2). Press these retaining clips in opposite directions to disengage heater block's connector from mother board assembly. In center of mother board, directly behind heater block, disconnect P8/J8, which is at end of ribbon cable. Slide E750 forward on bench so that approximately one-third of instrument is now extending beyond working surface. Using screwdriver, remove four (4) heater block retaining screws on bottom base plate. These screws hold heater block to base plate.

9.4.2 Power Supply PC Board Assembly A1A1

The following is a step-by-step procedure for removing the power supply PC board assembly from the E750.

1. Rotate E750 such that rear panel is facing forward.
2. Using screwdriver, loosen three (3) screws on back righthand section of back panel assembly. Turn three (3) screws in counter-clockwise direction minimum of three full turns.
3. Perform general disassembly procedure, paragraph 9.4.1 steps b and c.
4. Remove three (3) screws that secure power supply heat sink to rear panel via nut plate.
5. Remove printed circuit board assembly A1A1 (see Figure 11 -2).

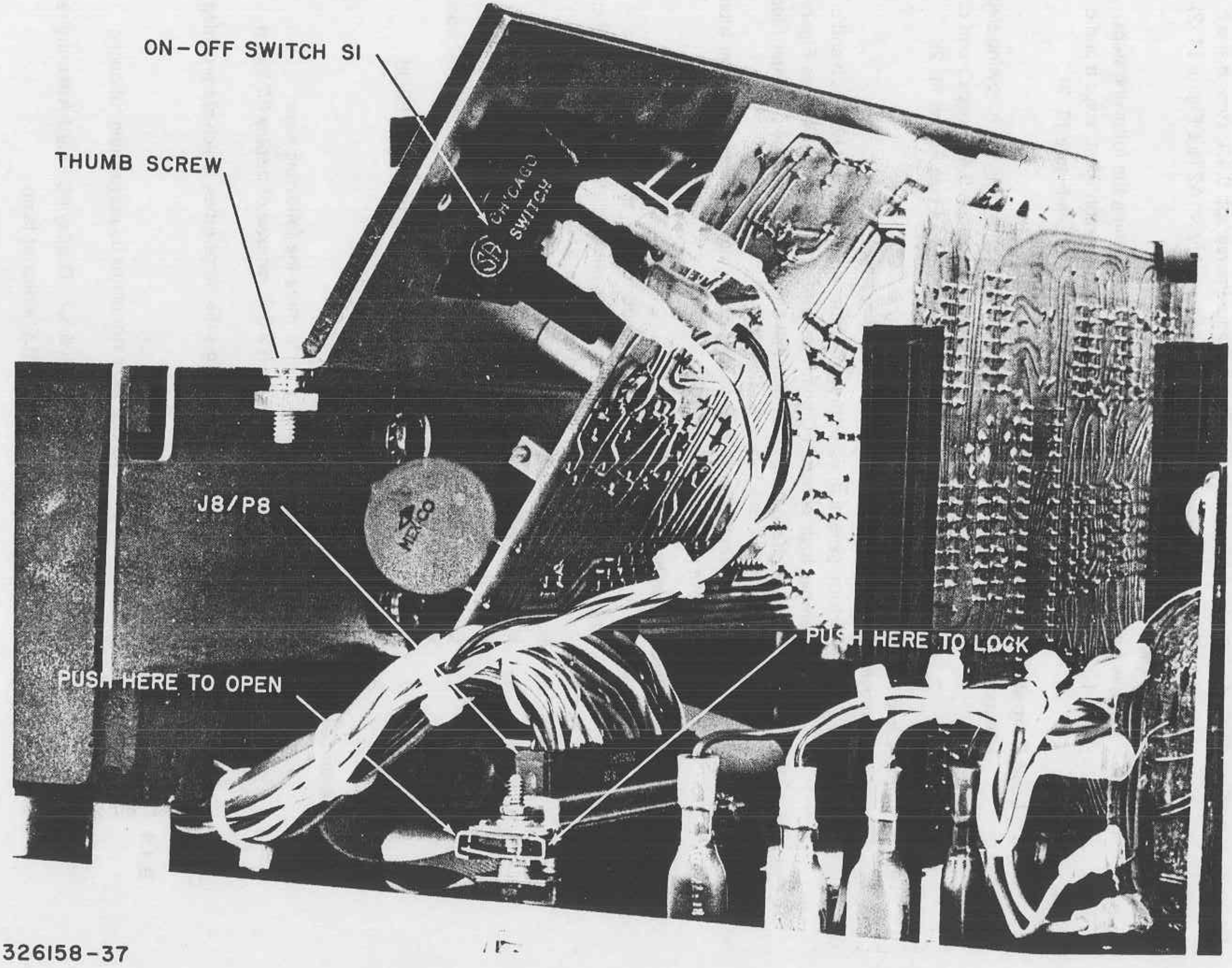

ON-OFF SWITCH SI
THUMB SCREW
J8/P8
PUSH HERE TO LOCK
PUSH HERE TO OPEN
CHICAGO SWITCH
MEXICO
326158-37

Figure 9-2. Heater Assembly A2 Removal

9.4.3 AC Power Heater PC Board Assembly A1A2

Remove AC power-heater board assembly A1A2 by performing the following steps:

1. Perform general disassembly procedure paragraph 9.4.1, steps b and c.
2. Remove AC power heater PC board assembly A1A2 (see Figure 11 -2).

9.4.4 Amplifier PC Board Assembly A1A3

Remove amplifier PC board assembly A1A3 by performing the following steps:

1. Perform general disassembly procedure paragraph 9.4.1, steps b and c.
2. Remove amplifier PC board assembly A1A3 (see Figure 11 -2).

9.4.5 Logic Control PC Board Assembly A1A4

Remove logic control PC board assembly A1A4 by performing the following steps:

1. Perform general disassembly procedure paragraph 9.4.1, steps b and c.
2. Remove logic control PC board assembly A1A4 (see Figure 11 -2).

9.4.6 Photo Lamp A2DS1

Remove photolamp by performing the following steps:

1. Perform general disassembly procedure paragraph 9.4.1, steps b and c.
2. Remove logic control PC board assembly designated A1A4 (see Figure 11 -2)
3. Remove photo lamp from terminal block located at side of heater block assembly A2 (see Figure 9 -3).
4. Remove thumb screw that secures photo lamp assembly to heater block.
5. Remove photo lamp assembly.

9.4.7 Display PC Board Assembly A2A2

Remove display PC board assembly A2A2 by performing the following steps:

1. Perform general disassembly procedure paragraph 9.4.1, steps b and c.
2. Remove logic control PC board assembly A1A4 (see Figure 11 -2).
3. Remove amplifier assembly A1A3 (see Figure 11 - 2)
4. Using 0.05 Allen wrench, remove mode switch knob.
5. Remove button from INCUBATION TIMER switch
6. Using screwdriver, remove three (3) screws that secure display PC board assembly to readout support bracket.
7. Disconnect ribbon cable from mother board at connector P8/J8
8. Remove display board A2A2.

9.4.8 Seven-Segment Gas Discharge Tubes

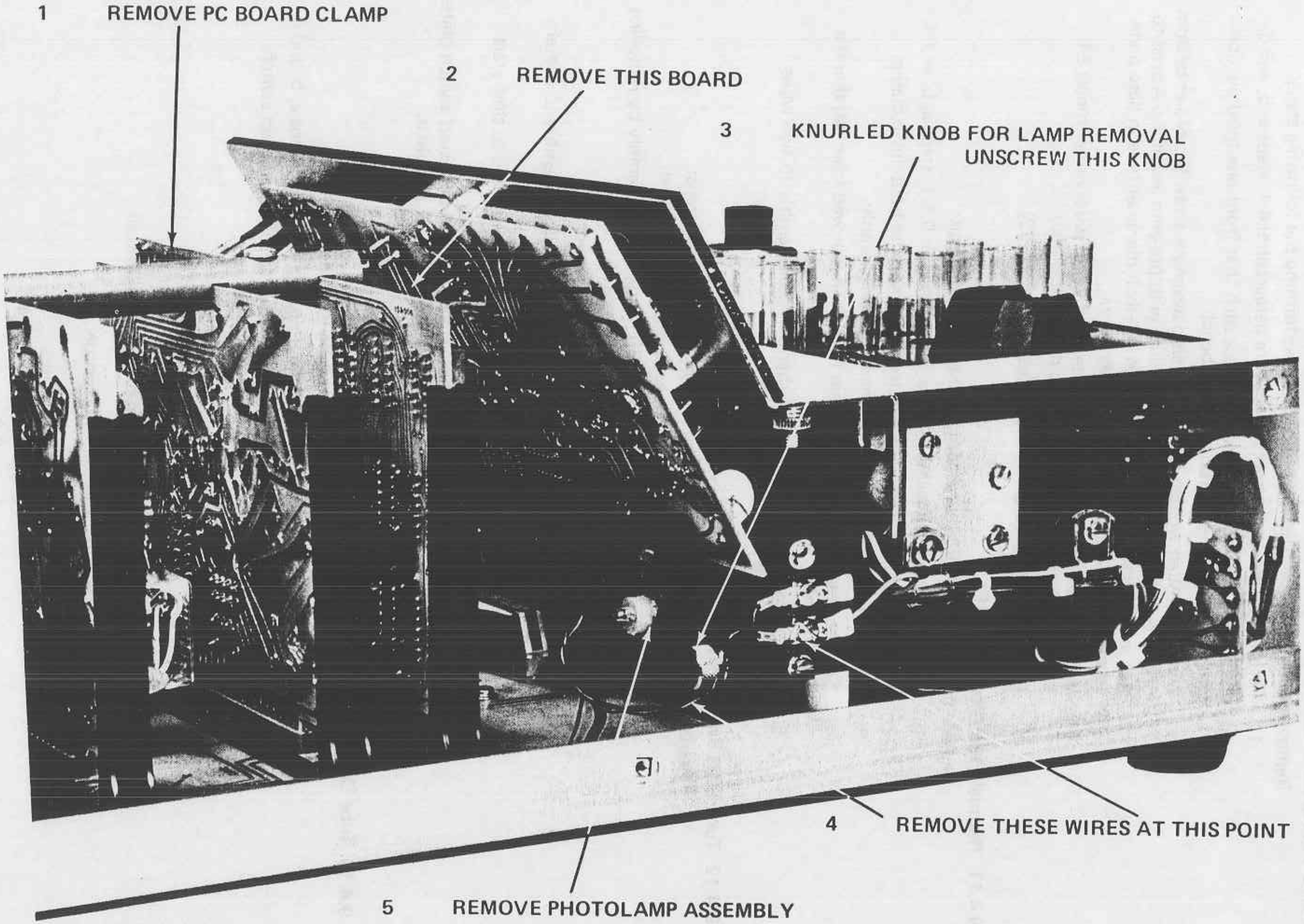
Replace gas-discharge display tubes by performing the following steps:

1. Perform procedure of paragraph 9.3.7, removal of display PC board assembly.
2. Replace plug-in seven-segment gas discharge tubes, which are provided in pairs.

9.4.9 AT-TEMP and OFF-SCALE Indicator Lamps

Replace AT-TEMP and OFF-SCALE indicator lamps by performing following procedure:

1. Perform procedure of paragraph 9.3.7 - Display PC Board Assembly removal.
2. Replace AT-TEMP or OFF-SCALE indicator lamp.


1 REMOVE PC BOARD CLAMP
2 REMOVE THIS BOARD
3 KNURLED KNOB FOR LAMP REMOVAL UNSCREW THIS KNOB
4 REMOVE THESE WIRES AT THIS POINT
5 REMOVE PHOTOLAMP ASSEMBLY

326158-35

Figure 9-3 Photolamp Replacement

9.4.10 Pre-Amp PC Board Assembly A2A1

Remove pre-amp PC board assembly A2A1 by performing the following steps:

1. Perform general disassembly procedure paragraph 9.4.1, steps a, b, and d.
2. Slide E750 forward on working surface such that front one-third portion of instrument is now sitting beyond bench.
3. With 7/64 Allen wrench, loosen pre-amp assembly screw located at bottom of heater block assembly directly in line with pre-amp assembly. Access to this retaining screw is gained through 1/4-inch diameter hole in base plate assembly directly below pre-amp assembly.
4. Using low wattage soldering iron, remove five (5) wires on terminals E1 through E5 located on left side of pre-amp assembly.
5. Remove pre-amp assembly A2A1 (see Figure 11 -12).

9.4.11 Thermal Fuse Assembly A2F1

Replace thermal fuse A2F1 by performing the following steps:

1. Perform general disassembly procedure paragraph 9.4.1, steps a, b. and d.
2. Using screwdriver, remove screw from thermal fuse hold-down clamp.
3. Using wire cutters, remove old thermal fuse assembly.
4. Strip back insulation on wires that have been removed from old thermal fuse assembly 1/4-inch.
5. Using crimping tool, secure new thermal fuse assembly to two wires and replace in hold down clamp.

9.4.12 Time Start Switch A2S2

Replace time start switch A2S2 by performing the following steps:

1. Perform general disassembly procedure, steps a, b, and d.
2. Remove test station from top of E750 heater block assembly by removing two (2) screws that secure it to heater block.
3. Remove time start switch plunger from test station.
4. Remove two (2) screws that secure time start switch assembly to heater block.
5. Using soldering iron, remove three wires that are attached to time start switch.
6. Remove two screws that secure time start switch to time start switch plate. Switch is secured to place through nut plate at back of switch.
7. Replace time start switch.

9.4.13 Tube Detect Switch A2S3

Remove tube detect switch A2S3 by performing the following steps:

1. Perform general disassembly procedure paragraph 9.4.1, steps a, b, and d.
2. Using soldering iron, remove three wires at rear of tube detect switch (see Figure 11 - 12).

CAUTION

When removing switch assembly exercise care to prevent

loss of spring, bearing, and shaft in chamber.

3. Remove screws that retain tube detect switch bracket to heater block assembly.
4. Remove tube detect switch from bracket by removing two screws that retain switch to bracket via nut plate.

CAUTION

After new detect switch has been reassembled onto E750 heater block, some adjustments may be required to insure proper actuation of tube detect switch.

9.4.14 Stirrer Motor Assembly A2M1

Remove stirrer motor assembly by performing the following steps:

1. Perform general disassembly procedure paragraph 9.4.1, steps a, b, d, and e.
2. Remove quick connect terminals attached to stirrer motor assembly from heater block harness.
3. Remove retaining two (2) screws that attach stirrer motor assembly.
4. Remove stirrer motor assembly.

9.4.15 Thermistor A2R1

Replace thermistor by performing the following steps:

Perform general disassembly procedure paragraph 9.4.1, steps a, b, c, and e.

2. Remove four (4) screws that retain readout support bracket to heater block assembly.
3. Remove thermistor from heater block assembly, Cut thermistor leads as close to harness as possible and discard old thermistor.
4. Using long nose pliers, remove pins 29 and 4 from connector A2P7 by pushing front of pin toward rear of connector. After pins are extracted, cut leads as close to harness as possible.
5. Install new thermistor by inserting two pins, one each, into pins 4 and 29 of connector A2P7.
6. Install thermistor into heat block assembly.
7. Secure loose wire from thermistor to heater block assembly harness with cable ties supplied with thermistor assembly.

CAUTION

When Display support bracket is reassembled onto heater block assembly, it must be adjusted as indicated in Figure 9 - 3.

9.4.16 Lamp Switch Assembly A3

Remove LAMP LEVEL switch assembly A3 by performing the following steps:

1. Remove power supply PC board assembly as indicated in Paragraph 9.3.2.
2. Remove retaining nut from switch assembly at back panel
3. Using soldering iron, remove two (2) wires from switch assembly.
4. Remove switch assembly.

9.4 17 Work Station Thermometer

Remove workstation thermometer by sliding a piece of paper under the thermometer as shown in Figure 3 -2 and pull straight up.

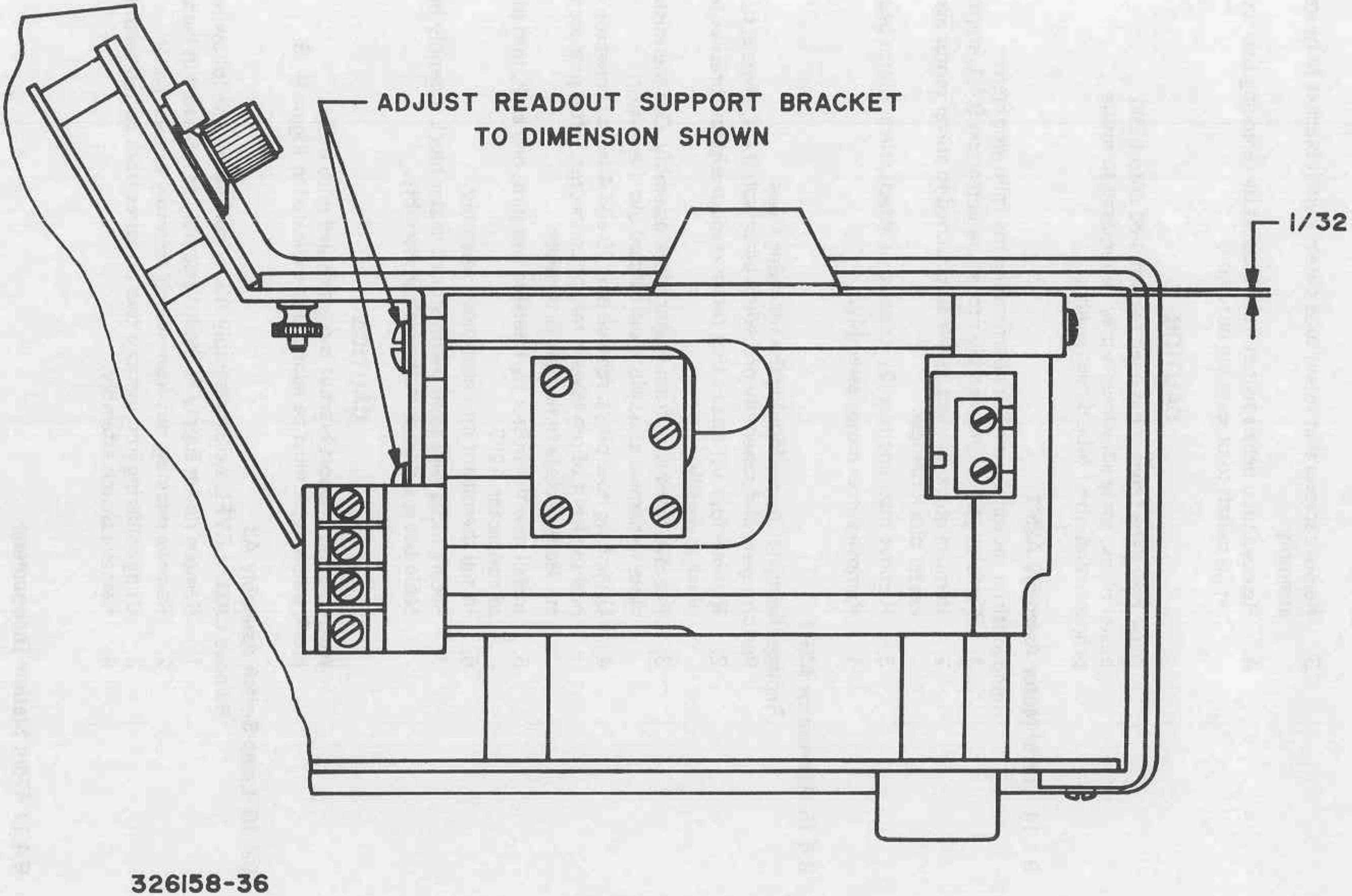

ADJUST READOUT SUPPORT BRACKET
TO DIMENSION SHOWN
1/32
326158-36

Figure 9-4. Display Bracket Alignment

SECTION 10

ADJUSTMENTS

10.1 INTRODUCTION

This section contains procedures for performing adjustments in the E750. There are eight (8) adjustable controls, six of which are field adjustable. The amplifier controls A1A3R37 and A1A3R24 are factory adjusted only. In addition, heater control A2R5 is also a factory adjustment which may be adjusted if proper equipment is available. This adjustment is time consuming and must be made under controlled conditions. (See paragraph 10.5.6)

10.2 ADJUSTMENTS

Adjustments in the E750 together with control designation and test points at which measurements must be made are provided in Table 10-1. In addition, Tables 7-3 through 7-5 show waveforms and voltage levels at various test points for applicable assemblies.

Table 10-1 E750 Adjustments

Adjustment	Control	Test Points	Level and Tolerance
+12 V power supply	A1A1R14	TP2 To TP1	+12VDC± 0.1V
-12 V power supply	A1A1R19	TP3 To TP1	-12VDC± 0.1V
Lamp power supply	A1A1R25 A1A1R33	A2TB1, 1 & 2	+2.75 VDC± 0.05V +5.5 VDC± 0.05V
+180V power supply	A2A2R5	4 To GND	+180VDC± 5.0V
Amplifier offset voltage	A1A3R24 A1A3R37	TP6 To TPI	See text
Heater temperature	A1A2R5	Incubation Station	37.2° C± 0.1° C

10.3 TEST EQUIPMENT

To make measurements or adjustments at an E750, a voltmeter capable of measuring as high as 180 volts and± 12 volts to within an accuracy of± 0.1 volt must be available. To make heater block temperature measurements or heater block temperature adjustments, a thermometer capable of measuring heater block temperature of 37.2° C± .1° must be used.

10.4 ORDER OF ADJUSTMENT

The order of adjustment must be performed as given. The indicated adjustments must be performed in pairs as shown with the first adjustment being performed first in each pair.

Order of Adjustments

$\left.\begin{array}{l}\text{+12 Volts}\\ \text{-12 Volts}\end{array}\right\}$ pair

$\left.\begin{array}{l}\text{2.75 Volts}\\ \text{5.5 Volts}\end{array}\right\}$ pair

Amplifier Offset*

+180 volt

Heater Temperature

* Factory adjustment-if necessary, adjust R24 first

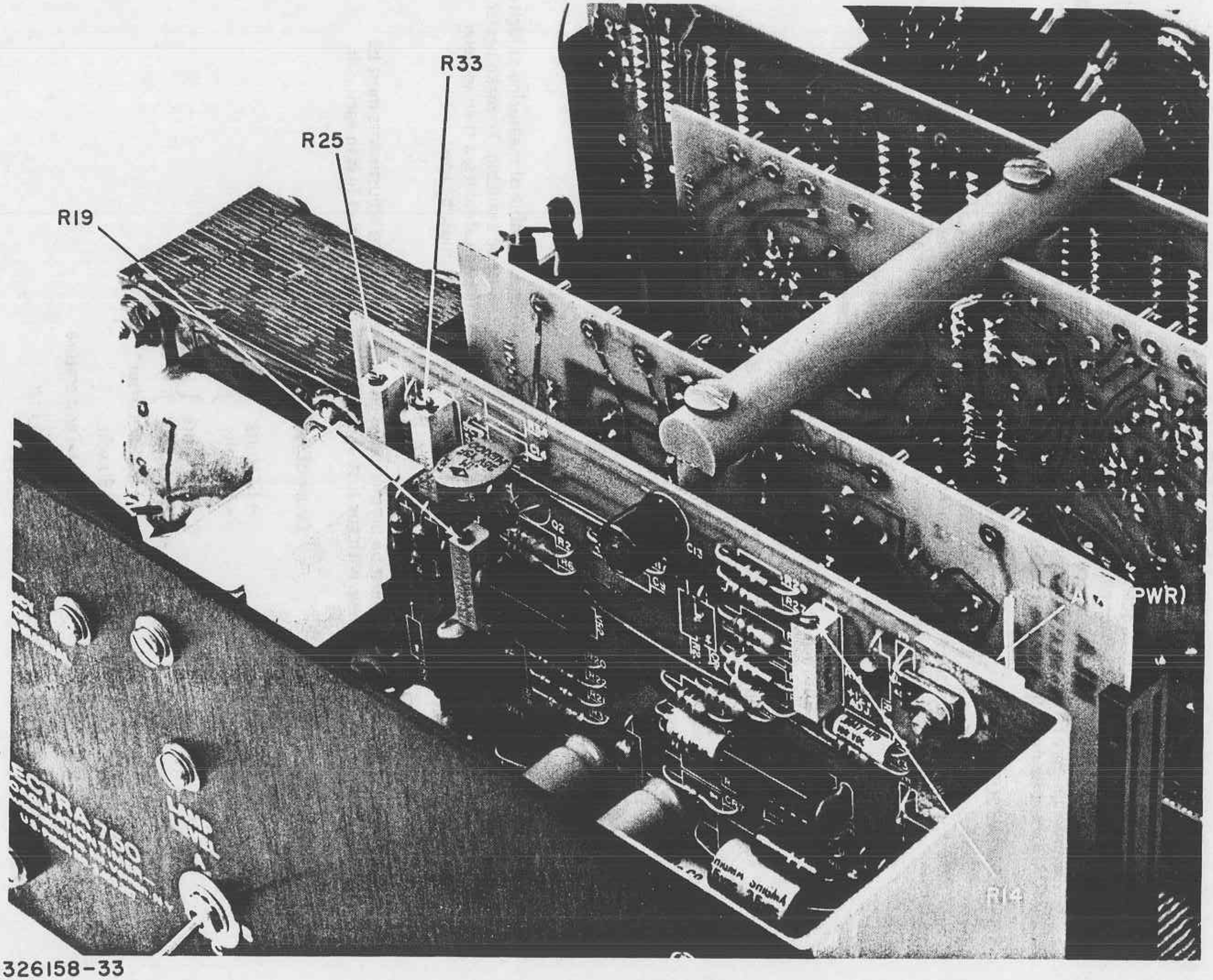

R33
R25
R19
A1 (PWR)
R14
LAMP LEVEL
326158-33

Figure 10-1. Location of Power Supply Adjustments

10.5 ADJUSTMENTS

Most of the adjustments in the E750 are power supply voltage adjustments (see Figure 10-1). Procedures for making these adjustments are prsented in the following paragraphs:

10.5.1 +12–volt Power Supply

Adjust +12–volt supply by performing the following steps:

a. Connect D.C. voltmeter positive and negative leads to test points TP2 and TPI, respectively, on A1A3, Amplifier PC B.

b. Adjust variable resistor R14 on power supply assembly A1A1 to obtain +12 volts± 0.1VDC.

10.5.2 -12–volt Power Supply

Adjust the -12–volt supply by performing the following Steps:

CAUTION

> When making power supply adjustments, the +12 volt supply must be adjusted first because the -12 volt supply tracks the +12 volt supply.

a. Connect D.C. voltmeter positive and negative leads to test points TPI and TP3, respectively, on power supply assembly A1A1.

b. Adjust variable resistor R19 on power supply assembly A1A1 to obtain -12 volts± 0.1VDC.

c. Recheck +12 volt level for +12 volts± 0.1 VDC.

10.5.3 Lamp Power Supply Adjustment

Measure lamp power supply voltage at terminal block TBI located at the side of the heater block to which the lamp is physically attached. The magnitude of the voltage is a function of lamp level switch S3 located on the rear panel.

Set the lamp power supply voltage as follows:

a. Using alligator clip leads, short terminals at lamp level switch located on rear panel across blue and grey wires that are input and output (Figure 11-19).

b. Adjust potentiometer A1A1R25 on power supply assembly A1A1 to plus 2.75 volts ± 0.05 VDC. Remove alligator clip from lead lamp level.

c. Set lamp level switch to A position.

d. Adjust R33 on power supply assembly A1A1 to 5.5 volts± 0.05VDC.

CAUTION

> 2.75 power supply adjustment must be made first, and 5.5 be made second.

e. After adjustments have been completed, measure voltage across lamp terminal block A2TBI. Chart below shows anticipated voltage for indicated switch position.

Switch Position	Voltage
A	5.5± 0.1VDC
B	4.25± 0.1VDC
C	3.5± 0.05VDC

10.5.4 +180 – volt Gas Discharge Display Voltage

Adjust the +180 – volt Gas Discharge Display Voltage 180 – volt supply by performing the following steps:

a. Connect D.C. voltmeter positive and negative leads to collector of transistor Q1 on display assembly A2A2 and ground, respectively. The + point is designated by a starred ④

b. Adjust variable resistor A2A2R5 (See Figure 10-2) to indicate 180 volts± 5VDC.

c. Check that gas discharge tubes are properly lit.

10.5.5 Amplifier bias (Offset) Adjustment

This procedure should be performed only on instructions from MLA Technical Services Department. To adjust the amplifier bias, perform the following steps:

CAUTION

> The bias voltage for amplifier A1A3U2 is dynamically adjusted at the factory. If readjustment is required and it must be performed in the field, it is only a temporary adjustment until the amplifier assembly can be replaced by a factory calibrated unit.

a. Connect D.C. voltmeter positive and negative leads to test points TP6 and TPI (ground), respectively.

b. Place mode selector switch in APTT mode.

c. Adjust variable resistor R24 on amplifier assembly A1A3 to provide meter indication of 8.8 millivolts D.C.

d. Place mode selector switch in THROMBIN mode.

e. Adjust variable resistor R37 on amplifier assembly A1A3 to provide meter indication of 2.8 millivolts D.C.

f. Recheck meter indication in APTT mode.

10.5.6 Heater Block Temperature

Check heater block temperature by performing the following steps:

a. Place 0.5cc of distilled water in cuvette and place it in incubation station number 5.

b. After allowing water to sit for 15 minutes minimum, measure temperature of water.

c. Check that temperature is 37.2° C± 0.1° C. If not, perform next step.

d. Adjust variable resistor R5 on AC Power-Heater Assembly A1A2 to bring temperature within range. Variable resistor R5 has 0.13° C per turn control with clockwise direction providing increase in temperature.

e. After a 20-minute settling period, repeat step C above.

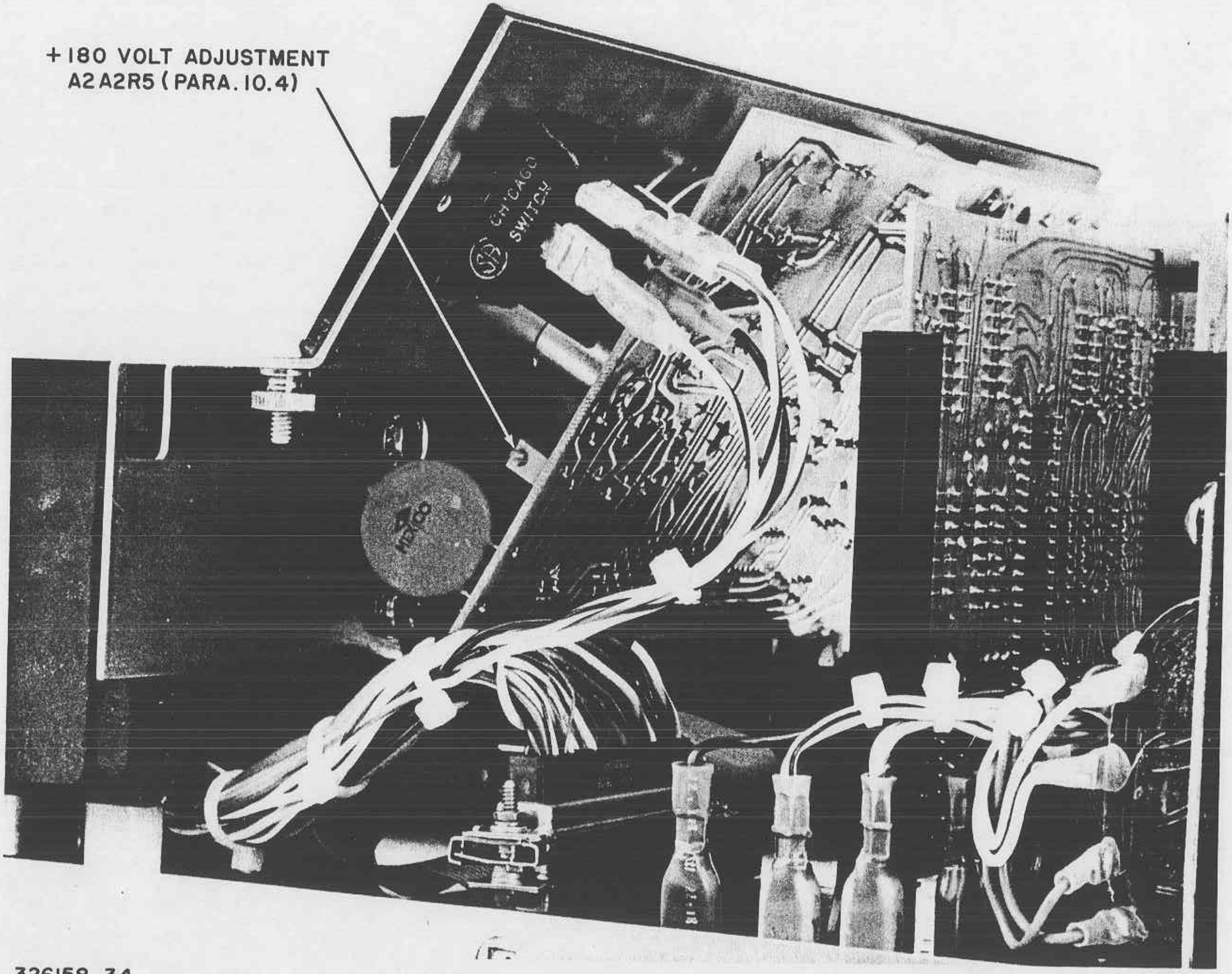

+180 VOLT ADJUSTMENT
A2A2R5 (PARA. 10.4)
CHICAGO SWITCH
326158-34

Figure 10-2. Location of +180 Volt Adjustment

SECTION 11

SCHEMATIC & PARTS LOCATION DIAGRAMS WITH PARTS LIST

11.1 INTRODUCTION

This section provides schematic diagrams of each assembly together with an interconnection diagram showing the interconnections on the mother board. Parts Location diagrams and photographs identify the location of all parts shown in the included parts list. For convenience, all data related to one assembly are grouped together in the following order: parts location diagram, parts list and schematic diagram.

11.2 SCHEMATIC SYMBOLS

Symbols used in the schematic diagrams are standard IEEE symbols. Additional symbols used together with the interpretation are shown in figure 11-1.

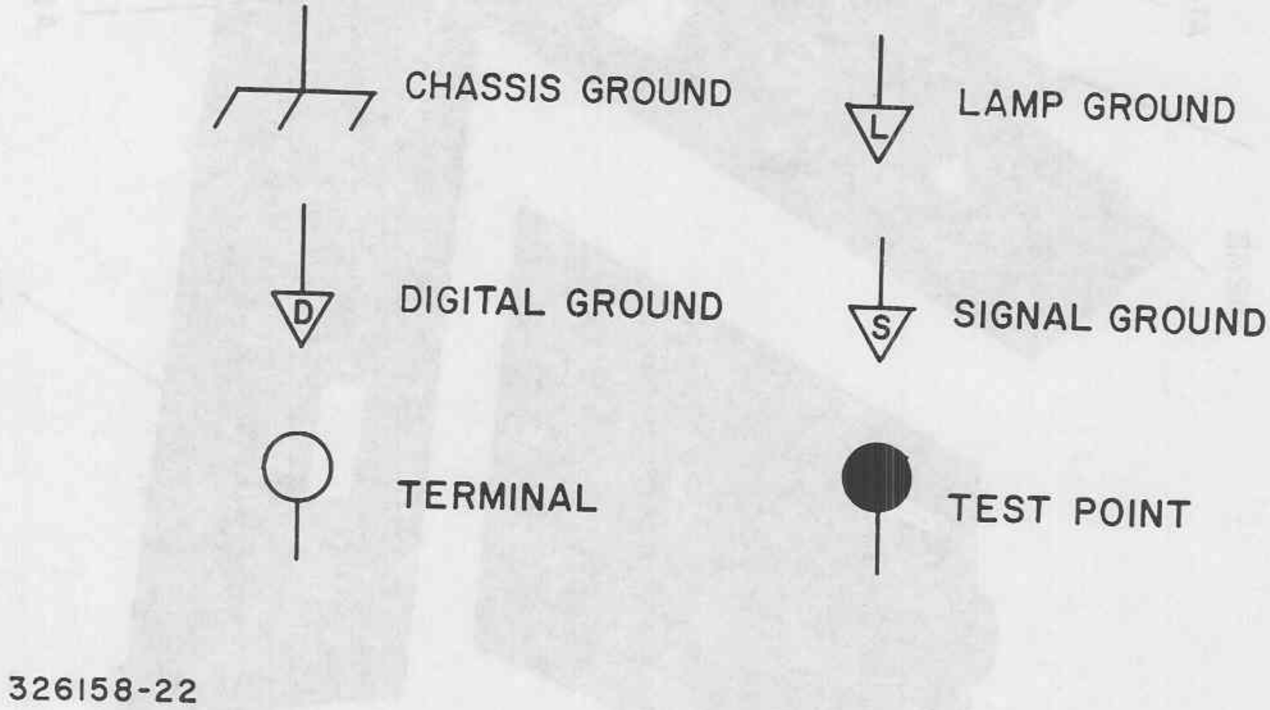

CHASSIS GROUND
L
LAMP GROUND
D
DIGITAL GROUND
S
SIGNAL GROUND
TERMINAL
TEST POINT
326158-22

Figure 11-1. Special Schematic Symbols

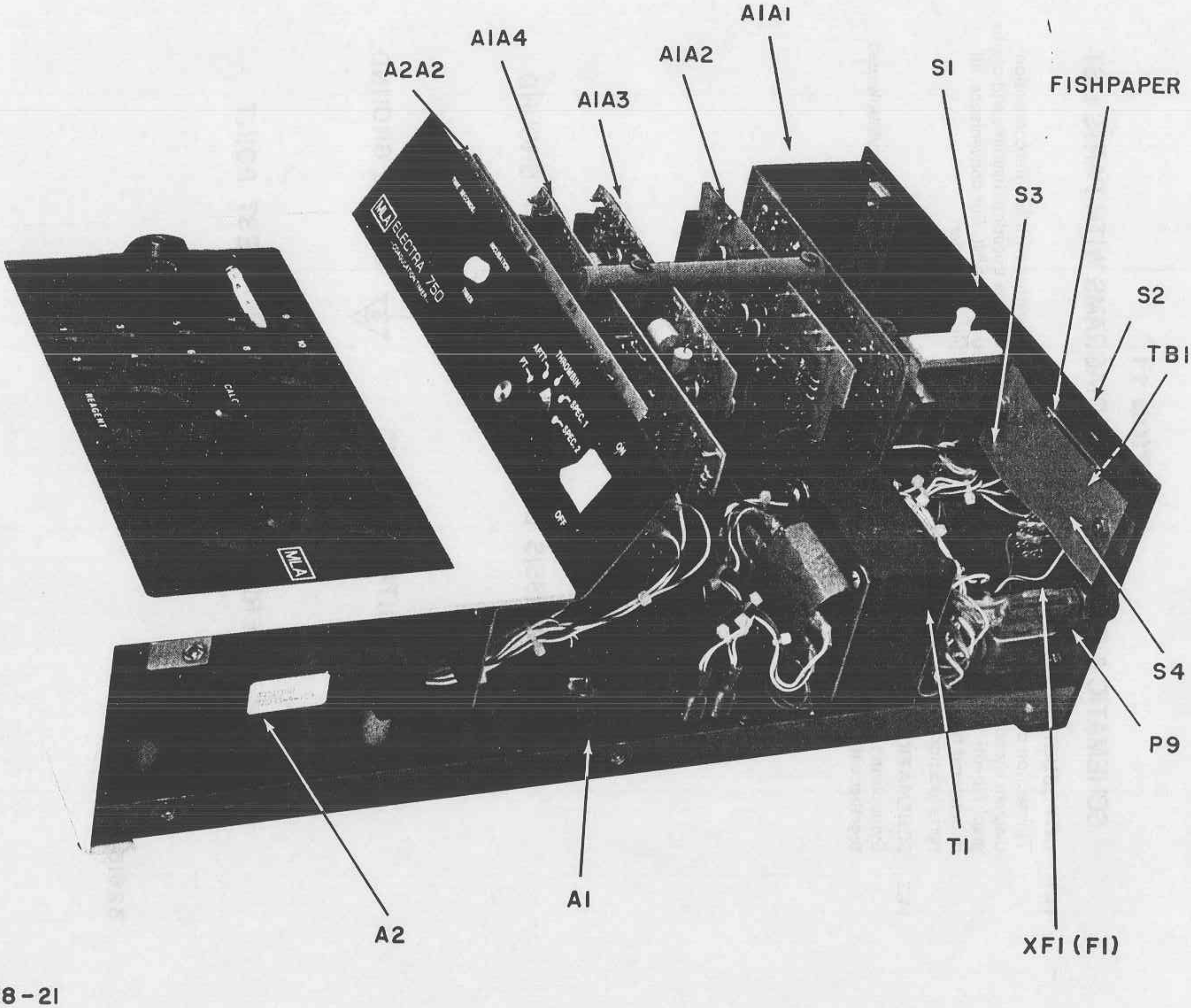
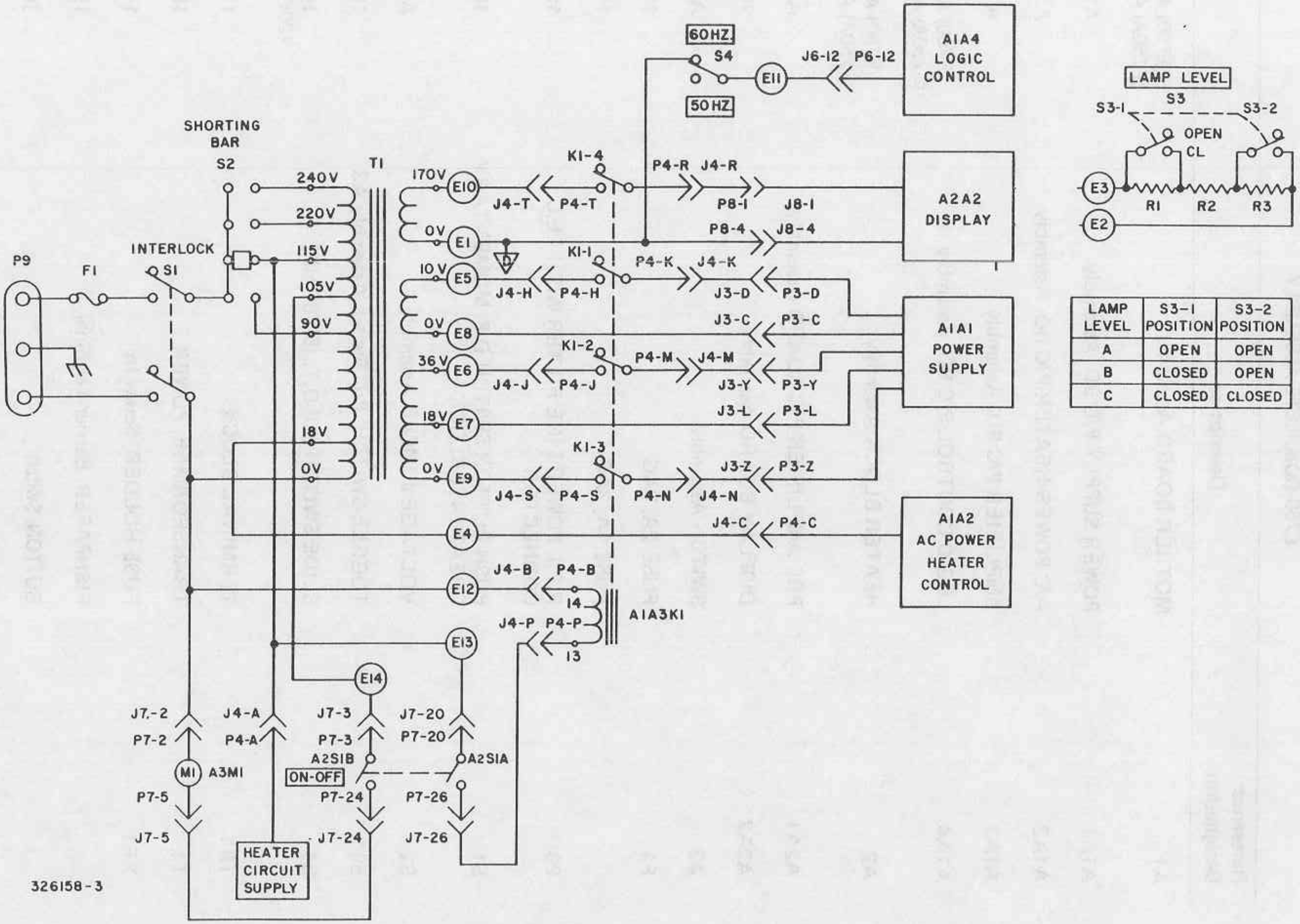

A1A1
A1A4
A2A2
A1A2
A1A3
S1
FISHPAPER
S3
S2
TB1
S4
P9
XF1 (F1)
T1
A1
A2
MLA ELECTRA 750 COAGULATION TIMER
THROMBIN
APTT
PT
SPEC. 1
SPEC. 2
ON
OFF
REAGENT
CALC
MLA
326158-21

Figure 11-2. Electra 750 Complete Assembly

PARTS LIST

E750 COMPLETE ASSEMBLY

Reference Designation	Description	M.L.A. Part No.
A1	MOTHER BOARD Assembly	(E750) A15E025 (E750A) A23E025
A1A1	POWER SUPPLY P/C BD. Assembly	A15D045
A1A2	A/C POWER-HEATER P/C BD. Assembly	A15D014
A1A3	AMPLIFIER P/C BD. Assembly	A15D015
A1A4	LOGIC CONTROL P/C BD. Assembly	(E750) A15D005 (E750A) A23D005
A2	HEATER BLOCK Assembly	(E750) A15D300 (E750A) A23B300
A2A1	PRE-AMPLIFIER P/C BOARD Assembly	A15B020
A2A2	DISPLAY BOARD Assembly	70141
A3	SWITCH Assembly	A15A048
F1	FUSE 2A, 3AG	11806
	FUSE 1A, 3AG	11805
P9	R.F.I. POWER LINE FILTER WITH I.E.C. CONNECTOR	10410
S1	PUSH BUTTON SWITCH D.P. MOMENTARY CHEAT INTERLOCK	10807
S2	VOLTAGE JUMPER Assembly	A15A210
S3*	TOGGLE SWITCH, P/O Switch Assembly A3	10833
S4	SLIDE SWITCH D.P.D.T. (50/60 HZ)	10863 (20C286)
TB1	TERMINAL BLOCK	12024
T1	TRANSFORMER, POWER	15B044
XF1	FUSE HOLDER, Screw In	11841
	FISHPAPER, Barrier Terminal	15A216
	BUTTON, Switch	10861
	LINE CORD	14992
	KNOB, Mode	30607



A1A4 LOGIC CONTROL
60HZ
50HZ
S4
E11
J6-12
P6-12
LAMP LEVEL
S3
S3-1
S3-2
OPEN
CL
E3
E2
R1
R2
R3
A2A2 DISPLAY
A1A1 POWER SUPPLY
A1A2 AC POWER HEATER CONTROL
SHORTING BAR
S2
T1
240V
220V
115V
105V
90V
18V
0V
170V
10V
36V
INTERLOCK
S1
P9
F1
E10
E1
E5
E8
E6
E7
E9
E4
E12
E13
E14
K1-4
K1-1
K1-2
K1-3
J4-T
P4-T
J4-H
P4-H
J4-J
P4-J
J4-S
P4-S
P4-R
J4-R
P8-1
J8-1
P8-4
J8-4
P4-K
J4-K
J3-D
P3-D
J3-C
P3-C
P4-M
J4-M
J3-Y
P3-Y
J3-L
P3-L
P4-N
J4-N
J3-Z
P3-Z
J4-C
P4-C
J4-B
P4-B
J4-P
P4-P
14
13
A1A3K1
J7-2
P7-2
M1
A3M1
P7-5
J7-5
J4-A
P4-A
HEATER CIRCUIT SUPPLY
J7-3
P7-3
A2S1B
ON-OFF
P7-24
J7-24
J7-20
P7-20
A2S1A
P7-26
J7-26
326158-3

LAMP LEVEL	S3-1 POSITION	S3-2 POSITION
A	OPEN	OPEN
B	CLOSED	OPEN
C	CLOSED	CLOSED

Figure 11-3. Primary Power Simplified Schematic Diagram

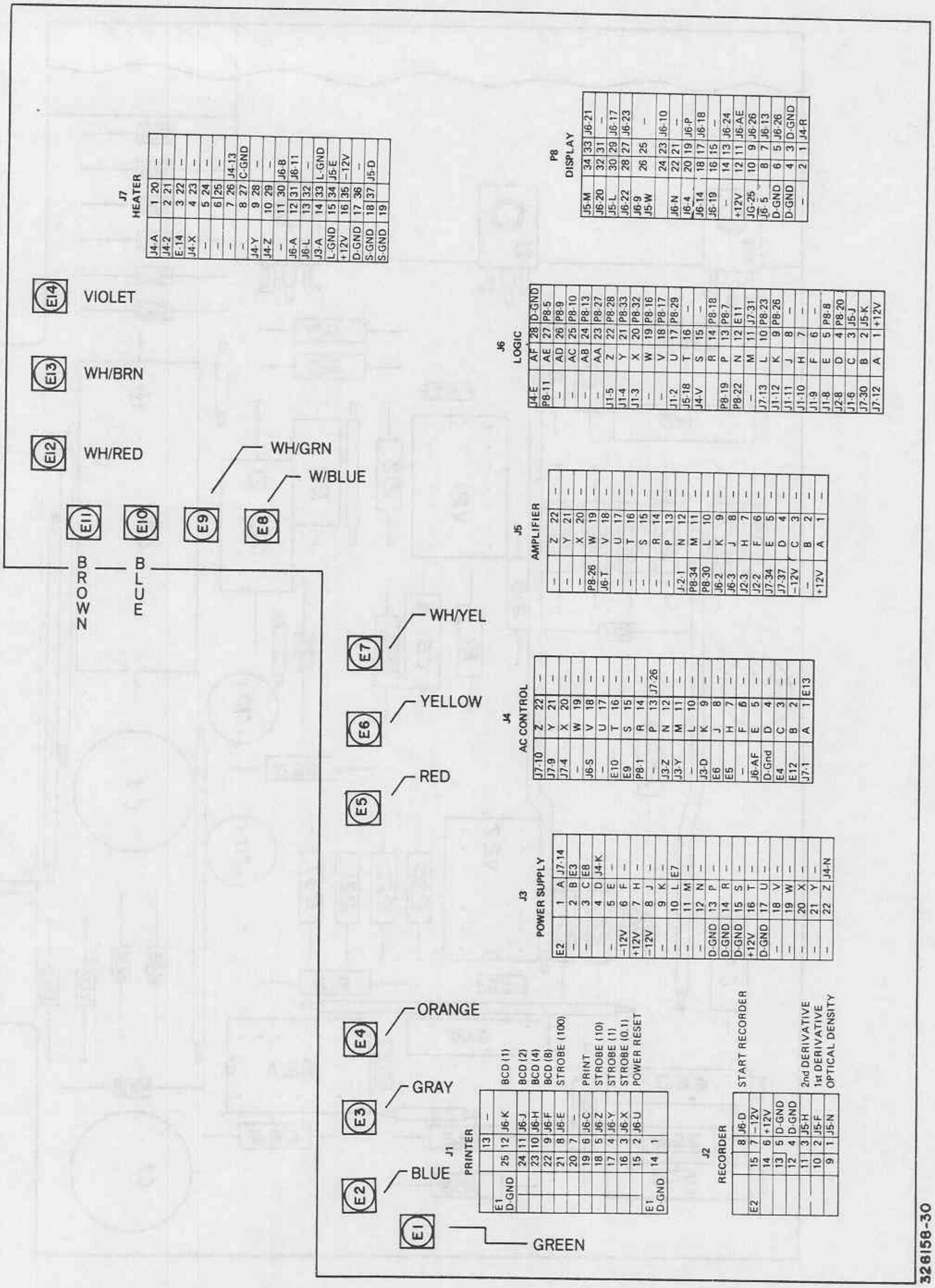

VIOLET
WH/BRN
WH/RED
WH/GRN
W/BLUE
BROWN
BLUE
WH/YEL
YELLOW
RED
ORANGE
GRAY
BLUE
GREEN
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
E11
E12
E13
E14
J7 HEATER
P8 DISPLAY
J6 LOGIC
J5 AMPLIFIER
J4 AC CONTROL
J3 POWER SUPPLY
J1 PRINTER
J2 RECORDER
BCD (1)
BCD (2)
BCD (4)
BCD (8)
STROBE (100)
PRINT
STROBE (10)
STROBE (1)
STROBE (0.1)
POWER RESET
START RECORDER
2nd DERIVATIVE
1st DERIVATIVE
OPTICAL DENSITY
326158-30

Figure 1.4. Typical Mother Board Assembly, A1 and Schematic Diagram

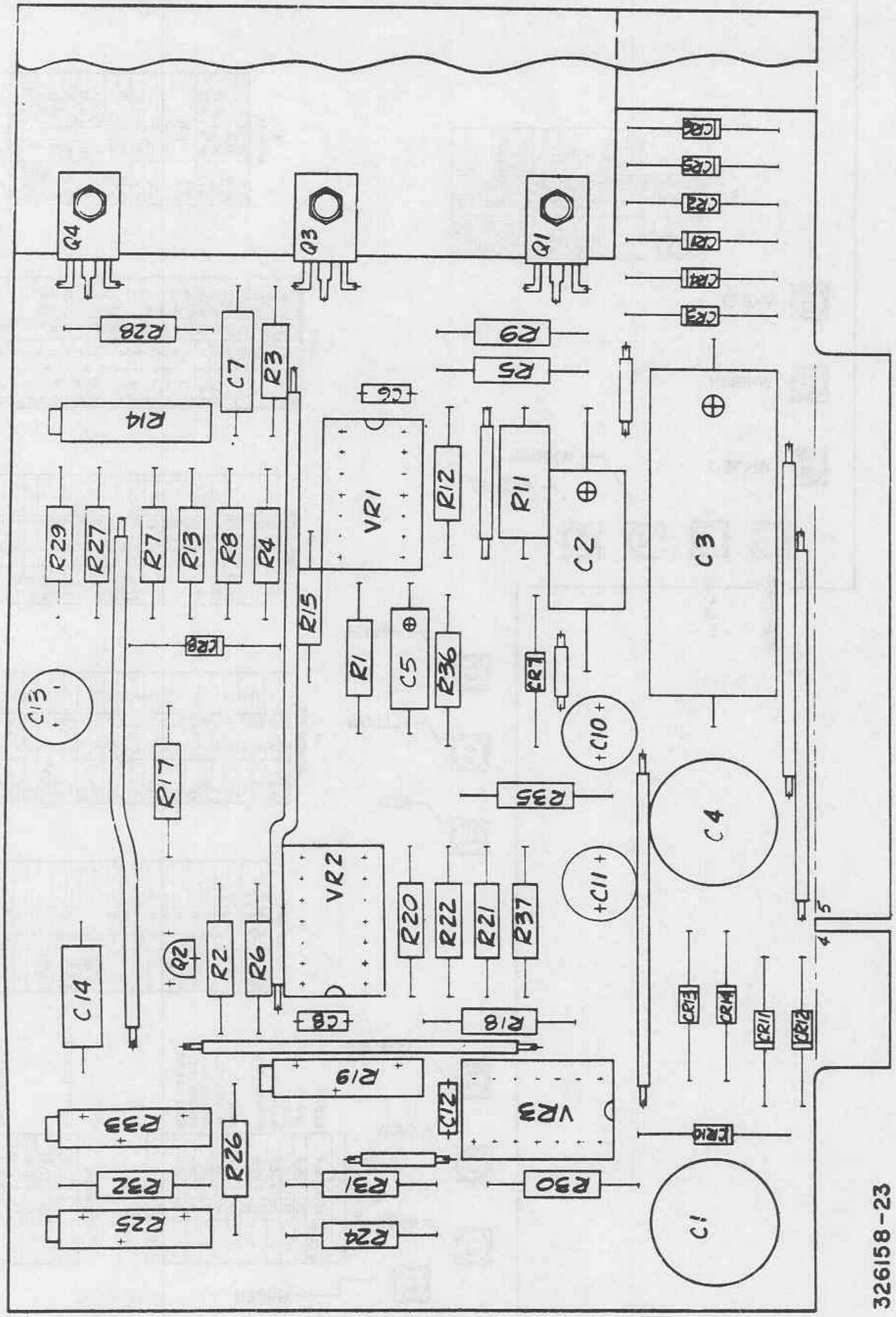

Q4
Q3
Q1
CR6
CR5
CR2
CR1
CR4
CR3
R28
C7
R3
R9
R5
C6
R14
VR1
R12
R11
C2
C3
R29
R27
R7
R13
R8
R4
R15
CR8
R1
C5
R36
CR7
C13
C10
R17
R35
C4
VR2
C11
R20
R22
R21
R37
5
4
C14
Q2
R2
R6
CR13
CR14
CR11
CR12
C8
R18
R19
C12
VR3
CR10
R33
R26
R32
R31
R30
R25
R24
C1
326158-23

Figure 11-5. Power Supply Assembly A1A1 (P/N A15D045)

PARTS LIST

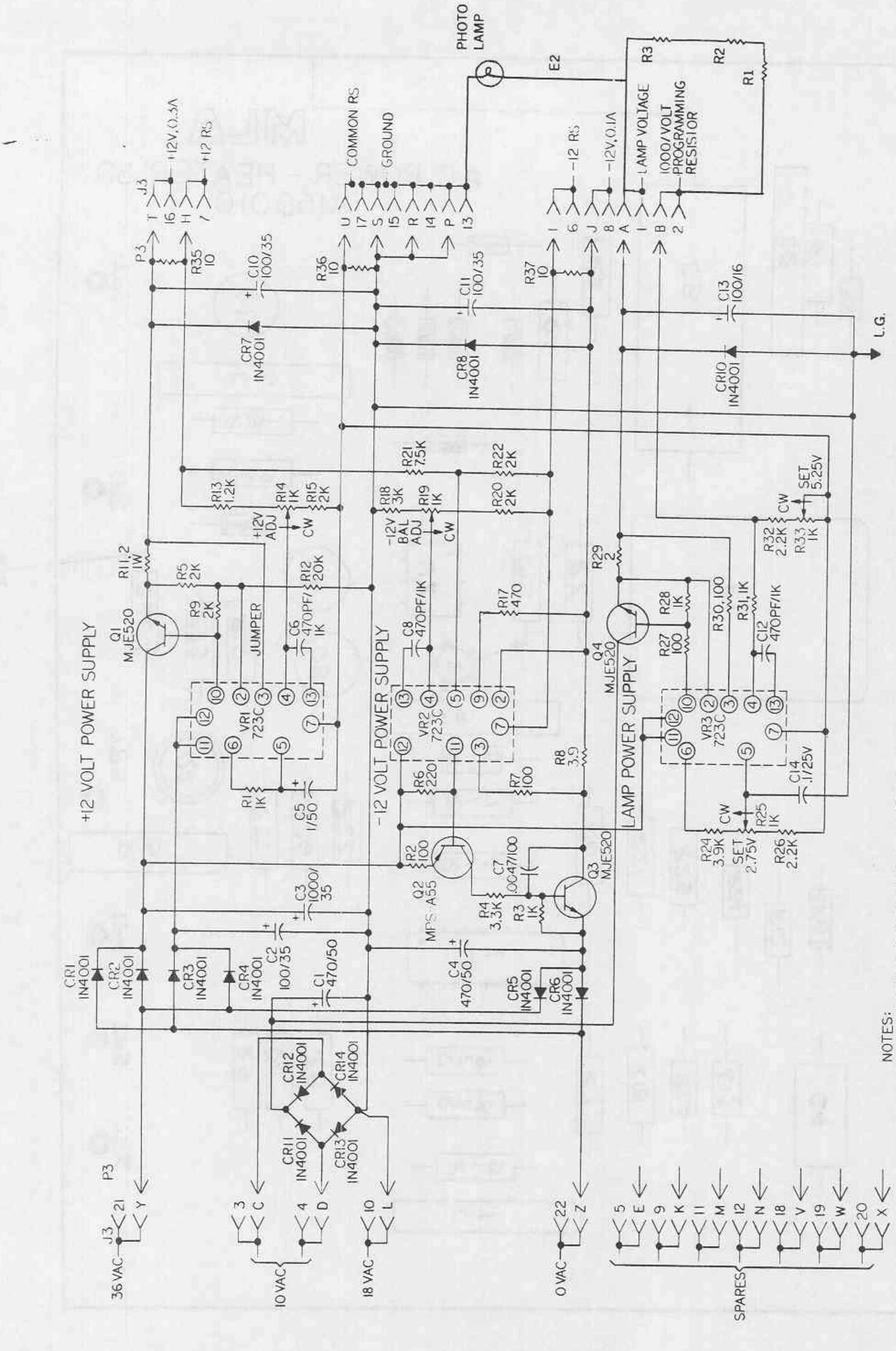
POWER SUPPLY P/C BD. ASSEMBLY A1A1 (Part No. A15D045)
(1 of 2)

Reference Designation	Description	MLA Part No.
C1	CAPACITOR, 470/50, ELECTROLYTIC	12566
C2	CAPACITOR, 100/35, ELECTROLYTIC	12573
C3	CAPACITOR, 1000/35, ELECTROLYTIC	12574
C4	CAPACITOR, 470/50, ELECTROLYTIC	12566
C5	CAPACITOR, 1/50, ELECTROLYTIC	12565
C6	CAPACITOR, 470 pf/1KV, CERAMIC	12583
C7	CAPACITOR, .0047/100, MYLAR	12560
C8	CAPACITOR, 470 pf/1KV, CERAMIC	12583
C10	CAPACITOR, 100/35, ELECTROLYTIC	12573
C11	CAPACITOR, 100/35, ELECTROLYTIC	12573
C12	CAPACITOR, 470 pf/1KV, CERAMIC	12583
C13	CAPACITOR, 100/16, ELECTROLYTIC	12559
C14	CAPACITOR, 0.1/25, 20% CERAMIC	12593
CR1	DIODE, 1N4001	12624
CR2	DIODE, 1N4001	12624
CR3	DIODE, 1N4001	12624
CR4	DIODE, 1N4001	12624
CR5	DIODE, 1N4001	12624
CR6	DIODE, 1N4001	12624
CR7	DIODE, 1N4001	12624
CR8	DIODE, 1N4001	12624
CR9	NOT USED	
CR10	DIODE, 1N4001	12624
CR11	DIODE, 1N4001	12624
CR12	DIODE, 1N4001	12624
CR13	DIODE, 1N4001	12624
CR14	DIODE, 1N4001	12624
Q1	TRANSISTOR, MJE 520, MOTOROLA	11638
Q2	TRANSISTOR, MPS-A55, MOTOROLA	11639
Q3	TRANSISTOR, MJE 520, MOTOROLA	11638
Q4	TRANSISTOR, MJE 520, MOTOROLA	11638
R1	RESISTOR, 1K, 1/2 watt, 5%	22801
R2	RESISTOR, 100, 1/2 watt, 5%	22842
R3	RESISTOR, 1k, 1/2 watt, 5%	22801
R4	RESISTOR, 3.3K, 1/2 watt, 5%	22803
R5	RESISTOR, 2K, 1/2 watt, 5%	22851
R6	RESISTOR, 220, 1/2 watt, 5%	22816
R7	RESISTOR, 100, 1/2 watt, 5%	22842
R8	RESISTOR, 3.9, 1/2 watt, 5%	22852
R9	RESISTOR, 2K, 1/2 watt, 5%	22851
R10	NOT USED	
R11	RESISTOR, 2, 1 watt, 5%	22895
R12	RESISTOR, 20K, 1/2 watt, 5%	22829
R13	RESISTOR, 1.2K, 1/2 watt, 5%	22823

PARTS LIST

POWER SUPPLY P/C BD. ASSEMBLY A1A1 (Part No. A15D045)
(2 of 2)

Reference Designation	Description	MLA Part No.
R14	RESISTOR, POT., 1K	12724
R15	RESISTOR, 2K, 1/2 watt, 5%	22851
R16	NOT USED	
R17	RESISTOR, 470, 1/2 watt, 5%	22811
R18	RESISTOR, 3K, 1/2 watt, 5%	22836
R19	RESISTOR, POT., 1K	12724
R20	RESISTOR, 2K, 1/2 watt, 5%	22851
R21	RESISTOR, 7.5K, 1/2 watt, 5%	22828
R22	RESISTOR, 2K, 1/2 watt, 5%	22851
R23	NOT USED	
R24	RESISTOR, 3.9K, 1/2 watt, 5%	22855
R25	RESISTOR, POT., 1K	12724
R26	RESISTOR, 2.2K, 1/2 watt, 5%	22802
R27	RESISTOR, 100, 1/2 watt, 5%	22842
R28	RESISTOR, 1K, 1/2 watt, 5%	22801
R29	RESISTOR, 2, 1/2 watt, 5%	22853
R30	RESISTOR, 100, 1/2 watt, 5%	22842
R31	RESISTOR, 1K, 1/2 watt, 5%	22801
R32	RESISTOR, 2.2K, 1/2 watt, 5%	22802
R33	RESISTOR, POT., 1K	12724
R34	NOT USED	
R35	RESISTOR, 10, 1/2 watt, 5%	22854
R36	RESISTOR, 10, 1/2 watt, 5%	22854
R37	RESISTOR, 10. 1/2 watt, 5%	22854
VR1	VOLTAGE REGULATOR, UA723C, SIGNETICS	13004
VR2	VOLTAGE REGULATOR, UA723C, SIGNETICS	13004
VR3	VOLTAGE REGULATOR, UA723C, SIGNETICS	13004
T1	TRANSFORMER	A15B044


+12 VOLT POWER SUPPLY
Q1 MJE520
R11 .2 1W
R5 2K
R9 2K
JUMPER
C6 470PF/1K
R12 20K
VR1 723C
R1 1K
C5 1/50
C3 1000/35
C2 100/35
C1 470/50
CR1 IN4001
CR2 IN4001
CR3 IN4001
CR4 IN4001
CR11 IN4001
CR12 IN4001
CR13 IN4001
CR14 IN4001
J3
P3
36 VAC
10 VAC
18 VAC
0 VAC
SPARES
21 Y
3 C
4 D
10 L
22 Z
5 E
9 K
11 M
12 N
18 V
19 W
20 X
-12 VOLT POWER SUPPLY
VR2 723C
C8 470PF/1K
R6 220
R7 100
R2 100
Q2 MPS A55
R4 3.3K
R3 1K
C7 .0047/100
Q3 MJE520
C4 470/50
CR5 IN4001
CR6 IN4001
R8 3.9
R17 470
R18 3K
R19 1K
-12V BAL ADJ
CW
R20 2K
R21 7.5K
R22 2K
R13 1.2K
R14 1K
R15 2K
+12V ADJ
CW
CR7 IN4001
C10 100/35
R35 10
T
16
H
7
+12V,0.3A
+12 RS
R36 10
U
17
S
15
R
14
P
13
COMMON RS
GROUND
C11 100/35
CR8 IN4001
R37 10
I
6
J
8
A
1
B
2
-12 RS
-12V,0.1A
LAMP VOLTAGE
1000/VOLT PROGRAMMING RESISTOR
R3
R2
R1
E2
PHOTO LAMP
C13 100/16
CR10 IN4001
L.G.
LAMP POWER SUPPLY
Q4 MJE520
R29 2
R28 1K
R27 100
R30 100
R31 1K
C12 470PF/1K
VR3 723C
R32 2.2K
R33 1K
CW
SET 5.25V
R24 3.9K
R25 1K
CW
SET 2.75V
R26 2.2K
C14 .1/25V

NOTES:

1. ALL CAPACITOR VALUES ARE EXPRESSED IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ARE 1/2W, ±5% UNLESS OTHERWISE SPECIFIED.
3. REFERENCE DESIGNATION PREFIX IS A1A1.

Figure 11-6. Power Supply Schematic Diagram

326158-24

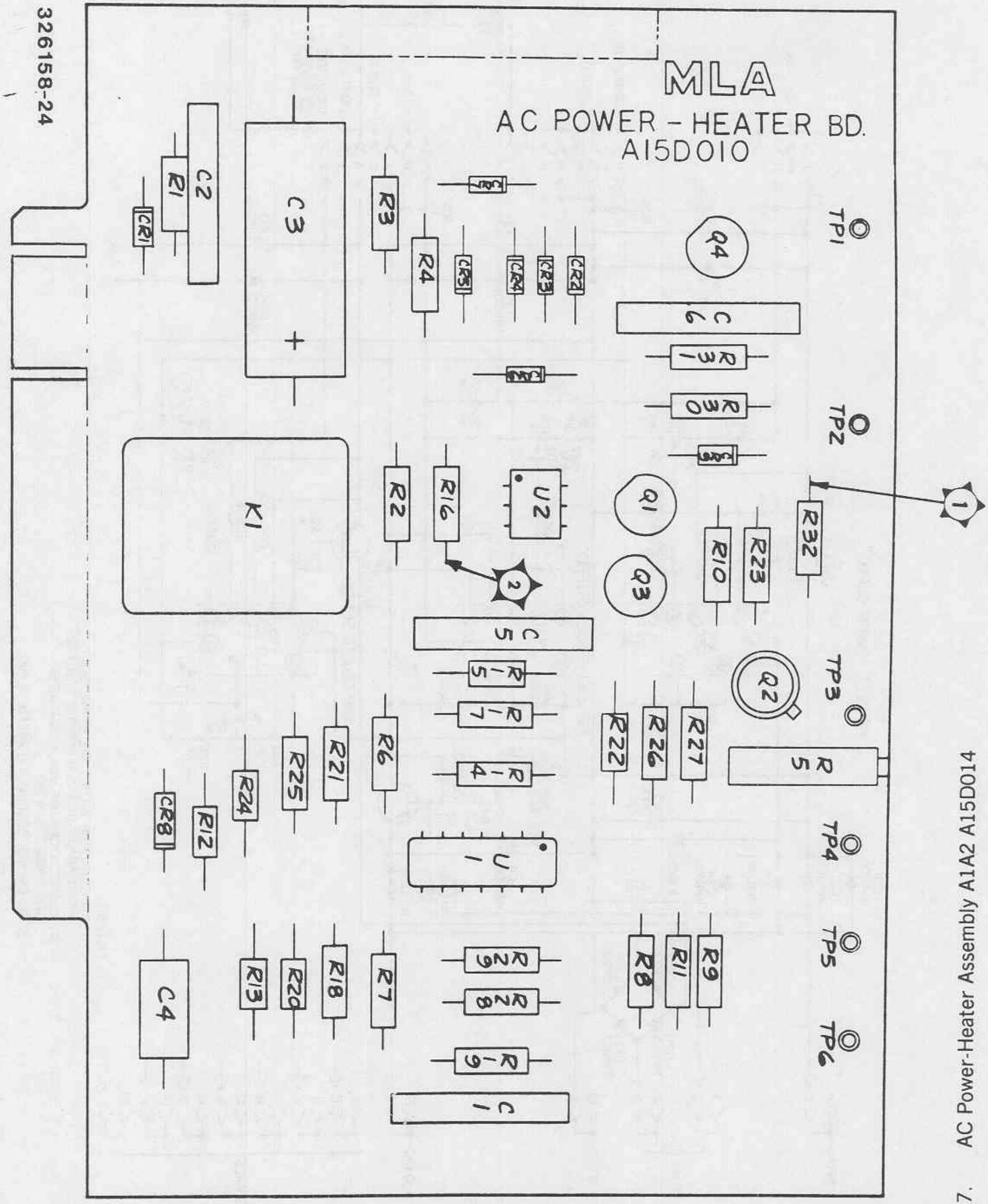

MLA
AC POWER - HEATER BD.
A15D010
TP1
TP2
TP3
TP4
TP5
TP6
Q1
Q2
Q3
Q4
C1
C2
C3
C4
C5
C6
CR1
CR2
CR3
CR4
CR5
CR8
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
R28
R29
R30
R31
R32
K1
U1
U2
+
1
2

Figure 11-7. AC Power-Heater Assembly A1A2 A15D014

Figure 11-7. AC Power-Heater Assembly A1A2 (P/N A15D014)

PARTS LIST

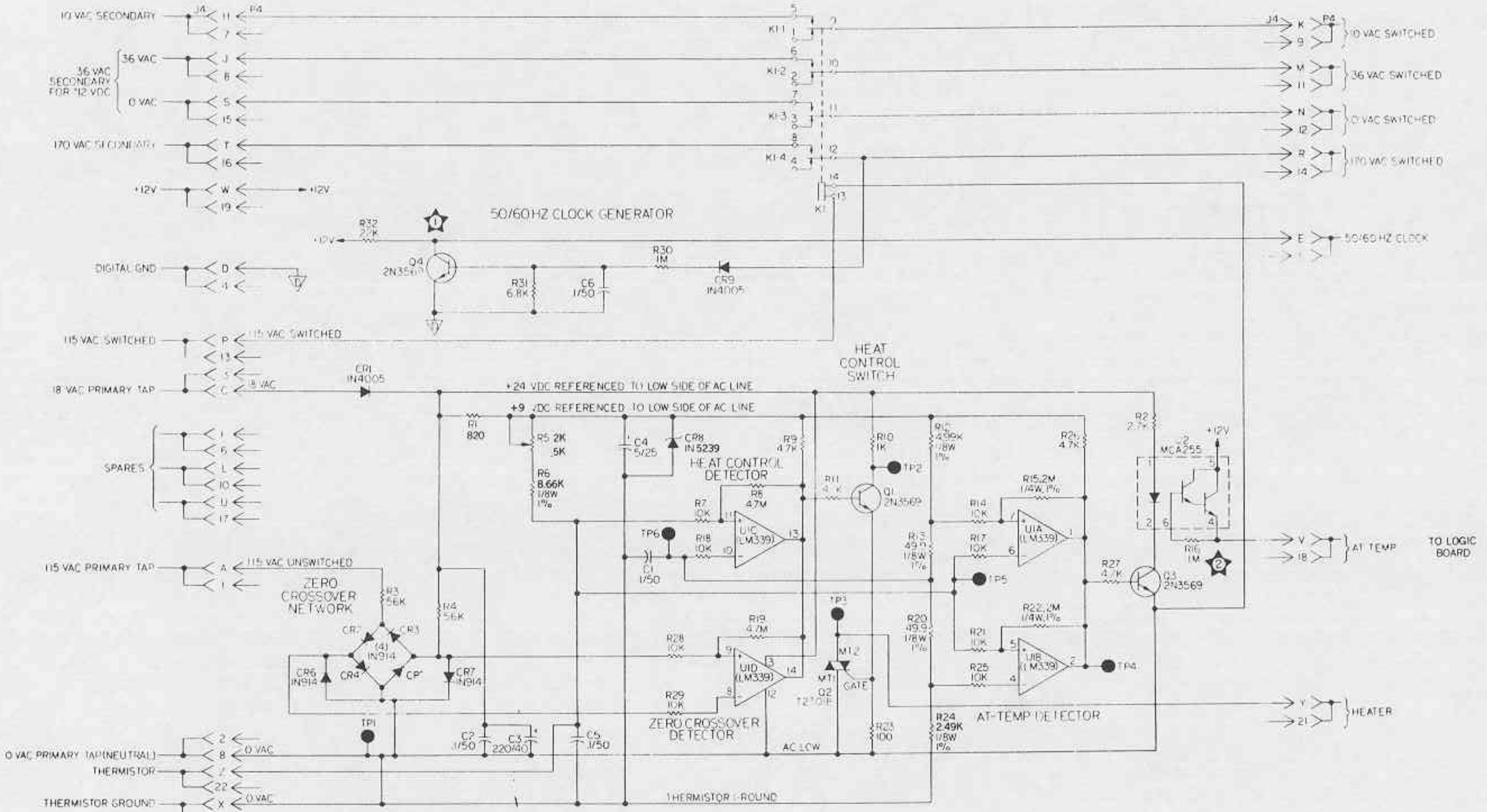
A/C POWER HEATER P/C BD. ASSEMBLY A1A2 (Part No. A15D014, (1 of 2)

Reference Designation	Description	MLA Part No.
C1	CAPACITOR, 0.1/50, 20%, CERAMIC	12596
C2	CAPACITOR, 0.1/50, 20%, CERAMIC	12596
C3	CAPACITOR, 220/40, ELECTROLYTIC	12557
C4	CAPACITOR, 5/25, ELECTROLYTIC	12591
C5	CAPACITOR, 0.1/50, 20%, CERAMIC	12596
C6	CAPACITOR, 0.1/50, 20%, CERAMIC	12596
CR1	DIODE, 1N4005	12620
CR2	DIODE, 1N914	12610
CR3	DIODE, 1N914	12610
CR4	DIODE, 1N914	12610
CR5	DIODE, 1N914	12610
CR6	DIODE, 1N914	12610
CR7	DIODE, 1N914	12610
CR8	DIODE, 1N5239	12629
CR9	DIODE, 1N4005	12620
K1	Relay, RAP 4A0/120, SCHRACK	11306
Q1	Transistor, 2N3569	11634
Q2	TRIAC, T2301B, RCA	11602
Q3	Transistor, 2N3569	11634
Q4	Transistor, 2N3569	11634
R1	RESISTOR, 820, 1/2 watt, 5%	22857
R2	RESISTOR, 2.7K, 1/2 watt, 5%	22849
R3	RESISTOR, 56K, 1/2 watt, 5%	22848
R4	RESISTOR, 56K, 1/2 watt, 5%	22848
R5	RESISTOR, POT., 2K-5K	12728
R6	RESISTOR, 8.66K, 1/8 watt, 1%	128137
R7	RESISTOR, 10K, 1/2 watt, 5%	22824
R8	RESISTOR, 4.7M, 1/2 watt, 5%	22850
R9	RESISTOR, 4.7K, 1/2 watt, 5%	22820
R10	RESISTOR, 1K, 1/2 watt, 5%	22801
R11	RESISTOR' 4.7K, 1/2 watt, 5%	22820
R12	RESISTOR, 4.99K 1/8 watt, 1%	128113
R13	RESISTOR, 49.9, 1/8 watt, 1%	128114
R14	RESISTOR, 10K, 1/2 watt, 5%	22824
R15	RESISTOR, 2M, 1/4 watt, 1%	128110
R16	RESISTOR, 1M, 1/2 watt, 5%	22812
R17	RESISTOR, 10K, 1/2 watt, 5%	22824
R18	RESISTOR, 10K, 1/2 watt, 5%	22824
R19	RESISTOR, 4.7M, 1/2 watt, 5%	22850

PARTS LIST

A/C POWER HEATER P/C BD. ASSEMBLY A1A2 (Part No. A15D014)
(2 of 2)

Reference Designation	Description	MLA Part No.
R20	RESISTOR, 49.9, 1/8 watt, 1%	128114
R21	RESISTOR, 10K, 1/2 watt, 5%	22824
R22	RESISTOR, 2M, 1/4 watt, 1%	128110
R23	RESISTOR' 100, 1/2 watt, 5%	22842
R24	RESISTOR, 2.49K, 1/8 watt, 1%	128131
R25	RESISTOR, 10K, 1/2 watt, 5%	22824
R26	RESISTOR, 4.7K, 1/2 watt, 5%	22820
R27	RESISTOR, 4.7K, 1/2 watt, 5%	22820
R28	RESISTOR, 10K, 1/2 watt, 5%	22824
R29	RESISTOR, 10K, 1/2 watt, 5%	22824
R30	RESISTOR, 1M, 1/2 watt, 5%	22812
R31	RESISTOR, 6.8K, 1/2 watt, 5%	22817
R32	RESISTOR, 22K, 1/2 watt, 5%	22846
U1	QUAD COMPARITOR, LM 339N, NATIONAL	13039
U2	OPTO-ISOLATOR, MCA255, MONSANTO	13024


10 VAC SECONDARY
J4
P4
36 VAC
36 VAC SECONDARY FOR 12 VDC
0 VAC
170 VAC SECONDARY
+12V
DIGITAL GND
115 VAC SWITCHED
18 VAC PRIMARY TAP
18 VAC
SPARES
115 VAC PRIMARY TAP
115 VAC UNSWITCHED
0 VAC PRIMARY TAP(NEUTRAL)
THERMISTOR
THERMISTOR GROUND
K1-1
K1-2
K1-3
K1-4
K1
10 VAC SWITCHED
36 VAC SWITCHED
0 VAC SWITCHED
170 VAC SWITCHED
50/60 HZ CLOCK GENERATOR
50/60 HZ CLOCK
R32 22K
Q4 2N3569
R31 6.8K
C6 1/50
R30 1M
CR9 IN4005
CR1 IN4005
+24 VDC REFERENCED TO LOW SIDE OF AC LINE
+9 VDC REFERENCED TO LOW SIDE OF AC LINE
R1 820
R5 2K .5K
R6 8.66K 1/8W 1%
C4 5/25
CR8 IN5239
HEAT CONTROL DETECTOR
R9 4.7K
R8 4.7M
R7 10K
R18 10K
TP6
C1 1/50
U1C (LM339)
HEAT CONTROL SWITCH
R10 1K
TP2
R11 4.7K
Q1 2N3569
R12 499K 1/8W 1%
R13 49.9 1/8W 1%
R20 49.9 1/8W 1%
R24 2.49K 1/8W 1%
R14 10K
R17 10K
R15 2M 1/4W, 1%
U1A (LM339)
TP5
R22 2M 1/4W, 1%
R21 10K
R25 10K
U1B (LM339)
TP4
R26 4.7K
AT-TEMP DETECTOR
R2 2.7K
U2 MCA255
+12V
R16 1M
R27 4.7K
Q3 2N3569
AT TEMP
TO LOGIC BOARD
HEATER
ZERO CROSSOVER NETWORK
R3 56K
R4 56K
CR2
CR3
(4) IN914
CR4
CR5
CR6 IN914
CR7 IN914
TP1
C2 1/50
C3 220/40
C5 1/50
R19 4.7M
R28 10K
R29 10K
U1D (LM339)
ZERO CROSSOVER DETECTOR
TP3
MT2
MT1
GATE
Q2 T2701F
R23 100
AC LOW
THERMISTOR GROUND

NOTES:
1. ALL RESISTORS ARE 1/2W, 5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE EXPRESSED IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. REFERENCE DESIGNATION PREFIX IS A1A2

Figure 11-8. AC Power-Heater Schematic Diagram

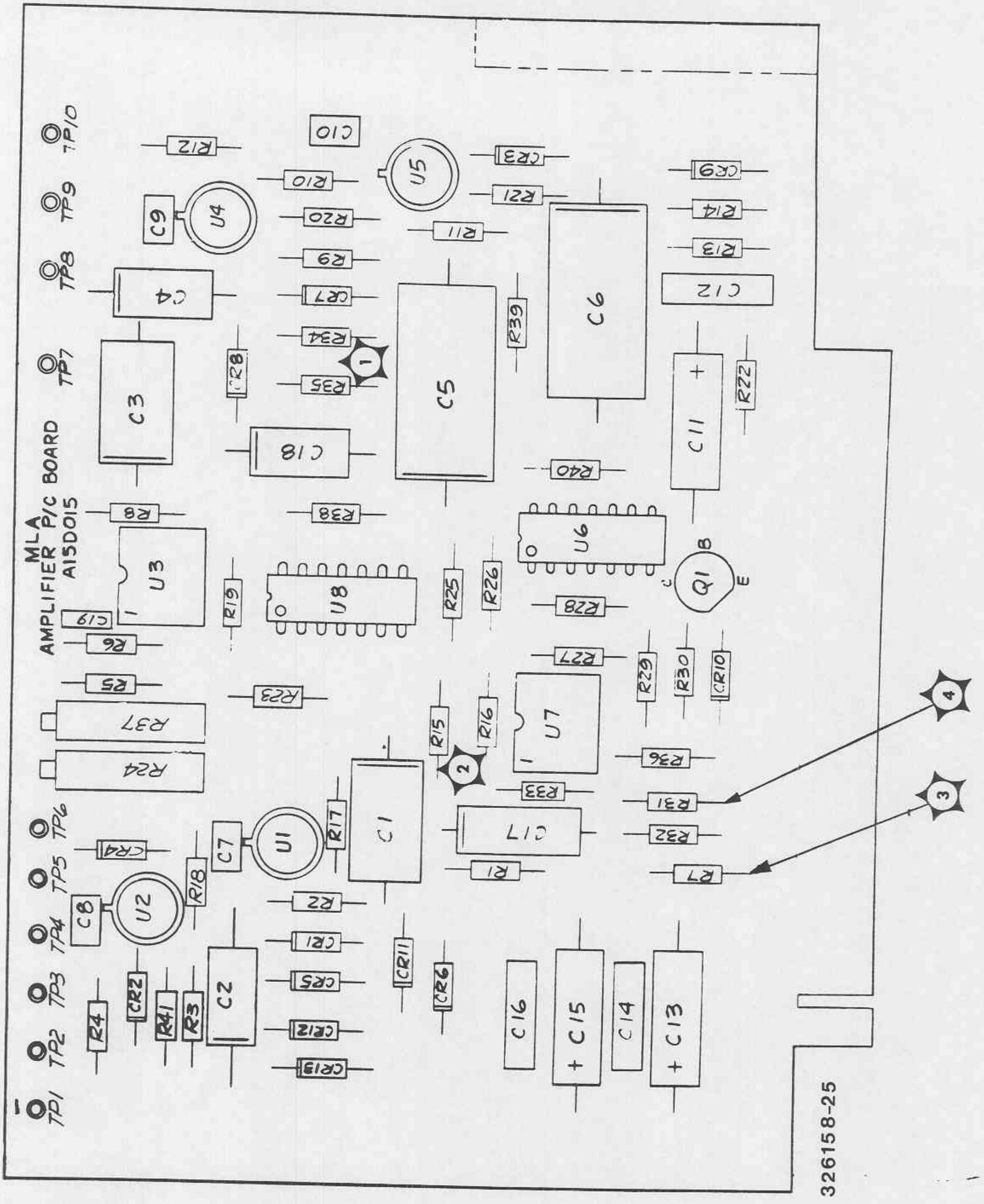

MLA
AMPLIFIER P/C BOARD
A15D015
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
TP9
TP10
1
2
3
4
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
CR9
CR10
CR11
CR12
CR13
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
R28
R29
R30
R31
R32
R33
R34
R35
R36
R37
R38
R39
R40
R41
U1
U2
U3
U4
U5
U6
U7
U8
Q1
B
C
E
+
326158-25

Figure 11-9. Amplifier Assembly A1A3 (P/N A15D015)

PARTS LIST

AMPLIFIER P/C BD. ASSEMBLY A1A3 (Part No. A15D015)
(1 of 2)

Reference Designation	Description	MLA Part No.
C1	CAPACITOR, 2.0/50, 5%, POLYCARBONATE	12568
C2	CAPACITOR, 0.47/50, 10%, POLYCARBONATE	12567
C3	CAPACITOR, 2.0/50, 5%, POLYCARBONATE	12568
C4	CAPACITOR, 0.47/50, 10%, POLYCARBONATE	12567
C5	CAPACITOR, 1.0/100, 10%, POLYCARBONATE	12576
C6	CAPACITOR, 1.0/100, 10%, POLYCARBONATE	12576
C7	CAPACITOR, 68 pf/1KV, 10%, CERAMIC	12594
C8	CAPACITOR, 68 pf/1KV, 10%, CERAMIC	12594
C9	CAPACITOR, 68 pf/1KV, 10%, CERAMIC	12594
C10	CAPACITOR, 68 pf/1KV, 10%, CERAMIC	12594
C11	CAPACITOR, 10/25, ELECTROLYTIC	12555
C12	CAPACITOR, 0.1/25, 20%, CERAMIC	12593
C13	CAPACITOR, 10/25, ELECTROLYTIC	12555
C14	CAPACITOR, 0.1/25, 20%, CERAMIC	12593
C15	CAPACITOR, 10/25, ELECTROLYTIC	12555
C16	CAPACITOR, 0.1/25, 20%, CERAMIC	12593
C17	CAPACITOR, 0.33/100, 10%, POLYCARBONATE	12575
C18	CAPACITOR, 0.47/50, 10%, POLYCARBONATE	12567
C19	CAPACITOR, 68 pf/1KV, 10%, CERAMIC	12594
C20	CAPACITOR, .01/1KV, 20%	12584
C21	CAPACITOR, .01/25V, 20%	12593
CR1	DIODE, 1N914	12610
CR2	DIODE, 1N914	12610
CR3	DIODE, 1N914	12610
CR4	DIODE, 1N914	12610
CR5	DIODE, 1N914	12610
CR6	DIODE, 1N914	12610
CR7	DIODE, 1N914	12610
CR8	DIODE, 1N914	12610
CR9	DIODE, 1N914	12610
CR10	DIODE, 1N914	12610
CR11	DIODE, 1N914	12610
CR12	DIODE, 1N914	12610
CR13	DIODE, 1N914	12610
Q1	TRANSISTOR, 2N3569	11634
R1	RESISTOR, 33.2K, 1/8 watt, 1%	128106
R2	RESISTOR, 2M, 1/4 watt, 1%	128110
R3	RESISTOR, 10K, 1/8 watt, 1%	128104
R4	RESISTOR, 10K, 1/8 watt, 1%	128104
R5	RESISTOR, 24.9K, 1/8 watt, 1%	128105
R6	RESISTOR, 301K, 1/8 watt, 1%	128125
R7	RESISTOR, 1K, 1/4 watt, 5%	228125

PARTS LIST

AMPLIFIER P/C BD. ASSEMBLY A1A3 (Part No. A15D015)
(2 of 2)

Reference Designation	Description	MLA Part No.
R8	RESISTOR, 270K, 1/4 watt, 5%	228154
R9	RESISTOR, 2M, 1/4 watt, 1%	128110
R10	RESISTOR, 100K, 1/8 watt, 1%	128107
R11	RESISTOR, 1M, 1/8 watt, 1%	128109
R12	RESISTOR, 1K, 1/4 watt, 5%	228125
R13	RESISTOR, 100K, 1/4 watt, 5%	228149
R14	RESISTOR, 15K, 1/4 watt, 5%	228139
R15	RESISTOR, 1K, 1/4 watt, 5%	228125
R16	RESISTOR, 1M, 1/4 watt, 5%	228161
R17	RESISTOR, 2M, 1/4 watt, 1%	128110
R18	RESISTOR, 3.3K, 1/4 watt, 5%	228131
R19	RESISTOR, 22K, 1/4 watt, 5%	228141
R20	RESISTOR, 2M, 1/4 watt, 1%	128110
R21	RESISTOR, 100K, 1/4 watt, 5%	228149
R22	RESISTOR, 2K, 1/8 watt, 1%	12874
R23	RESISTOR, 165K, 1/8 watt, 1%	128122
R24	RESISTOR, POT., 1K	12724
R25	RESISTOR, 100K, 1/4 watt, 5%	228149
R26	RESISTOR, 110K, 1/8 watt, 1%	128123
R27	RESISTOR, 133K, 1/8 watt, 1%	128124
R28	RESISTOR; 110K, 1/8 watt, 1%	128123
R29	RESISTOR, 10K, 1/4 watt, 5%	228137
R30	RESISTOR, 133K, 1/8 watt, 1%	128124
R31	RESISTOR, 49.9K, 1/8 watt, 1%	128112
R32	RESISTOR, 100K, 1/8 watt, 1%	128107
R33	RESISTOR, 200K, 1/8 watt, 1%	128111
R34	RESISTOR, 4.7M, 1/4 watt, 5%	228169
R35	RESISTOR, 47K, 1/4 watt, 5%	228145
R36	RESISTOR, 27K, 1/4 watt, 5%	228142
R37	RESISTOR, POT., 250K	12734
R38	RESISTOR, 22K, 1/4 watt, 5%	228141
R39	RESISTOR, 1K, 1/4 watt, 5%	228125
R40	RESISTOR, 2.2M, 1/4 watt, 5%	228165
R41	RESISTOR, 10K, 1/8 watt, 1%	128104
U1	OPERATIONAL AMPLIFIER, LM 308 AH, NATIONAL	13044
U2	OPERATIONAL AMPLIFIER, LM 308 AH, NATIONAL	13044
U3	OPERATIONAL AMPLIFIER, LM 308 AN, NATIONAL	13049
U4	OPERATIONAL AMPLIFIER, LM 308 AH, NATIONAL	13044
U5	OPERATIONAL AMPLIFIER, LM 308 AH, NATIONAL	13044
U6	OPERATIONAL AMPLIFIER, LM 339 N, NATIONAL	13039
U7	OPERATIONAL AMPLIFIER, MC 1741 NC-PL, MOTOROLA	13061
U8	QUAD BILATERAL SWITCH, MC 14016 CP, MOTOROLA	13040

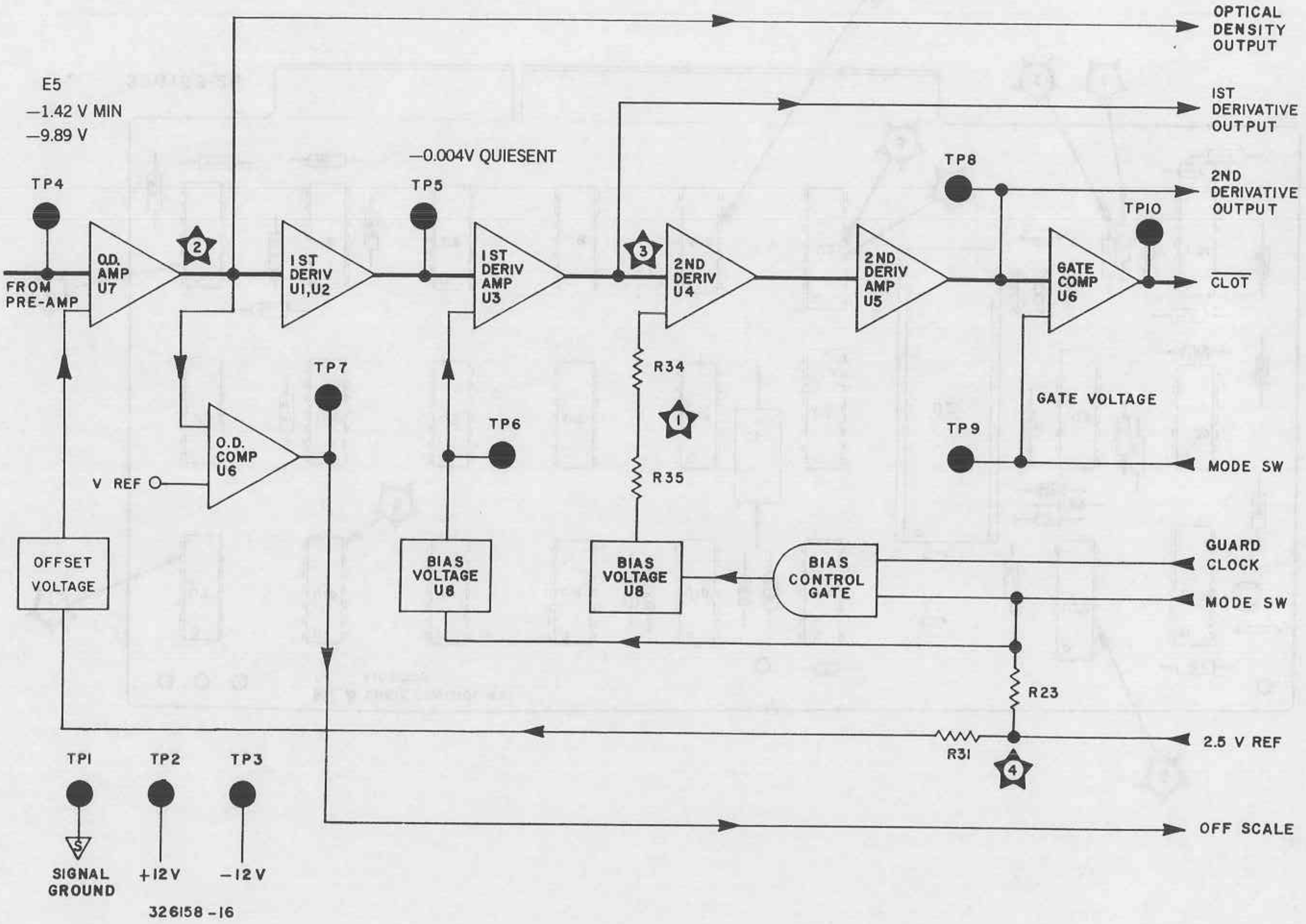

E5
−1.42 V MIN
−9.89 V
TP4
FROM PRE-AMP
O.D. AMP U7
2
−0.004V QUIESENT
TP5
IST DERIV U1,U2
IST DERIV AMP U3
3
2ND DERIV U4
2ND DERIV AMP U5
TP8
TP10
GATE COMP U6
OPTICAL DENSITY OUTPUT
IST DERIVATIVE OUTPUT
2ND DERIVATIVE OUTPUT
CLOT
TP7
O.D. COMP U6
V REF
TP6
R34
1
R35
GATE VOLTAGE
TP9
MODE SW
OFFSET VOLTAGE
BIAS VOLTAGE U8
BIAS VOLTAGE U8
BIAS CONTROL GATE
GUARD CLOCK
MODE SW
R23
R31
4
2.5 V REF
OFF SCALE
TP1
TP2
TP3
SIGNAL GROUND
+12V
−12V
326158 −16

Figure 11-10. Amplifier Simplified Schematic Diagram

PARTS LIST

LOGIC CONTROL P/C BD. ASSEMBLY A1A4 (Part No. A15D005)

(1 of 2)

Reference Designation	Description	MLA Part No.
C1	CAPACITOR, 150 pf/1KV, 10%, CERAMIC	12597
C2	CAPACITOR, 150 pf/1KV, 10%, CERAMIC	12597
C3	CAPACITOR, 150 pf/1KV, 10%, CERAMIC	12597
C4	CAPACITOR' 150 pf/1KV, 10%, CERAMIC	12597
C5	CAPACITOR, 0.001/1KV, 10%, CERAMIC	12516
C6	CAPACITOR, 100/25, TANTALUM	12530
CR1	DIODE, 1N914	12610
CR2	DIODE, 1N914	12610
CR3	DIODE, 1N914	12610
CR4	DIODE, 1N914	12610
CR5	DIODE, 1N914	12610
CR6	DIODE, 1N914	12610
CR7	DIODE, 1N914	12610
CR8	DIODE, 1N914	12610
CR9	DIODE, 1N914	12610
CR10	DIODE, 1N914	12610
R1	RESISTOR, 22K, 1/4 watt, 5%	228141
R2	RESISTOR, 22K, 1/4 watt, 5%	228141
R3	RESISTOR, 22K, 1/4 watt, 5%	228141
R4	RESISTOR, 390K, 1/4 watt, 5%	228156
R5	RESISTOR, 820K, 1/4 watt, 5%	228160
R6	RESISTOR, 22K, 1/4 watt, 5%	228141
R7	RESISTOR, 22K, 1/4 watt, 5%	228141
R8	RESISTOR, 22K, 1/4 watt, 5%	228141
R9	RESISTOR, 22K, 1/4 watt, 5%	228141
R10	RESISTOR, 22K, 1/4 watt, 5%	228141
R11	RESISTOR, 22K, 1/4 watt, 5%	228141
R12	RESISTOR, 22K, 1/4 watt, 5%	228141
R13	RESISTOR, 22K, 1/4 watt, 5%	228141
R14	RESISTOR, 22K, 1/4 watt, 5%	228141
R15	RESISTOR, 390K, 1/4 watt, 5%	228156
R16	RESISTOR, 100K, 1/4 watt, 5%	228149
R17	RESISTOR, 22K, 1/4 watt, 5%	228141
R18	RESISTOR, 22K, 1/4 watt, 5%	228141
R19	RESISTOR, 22K, 1/4 watt, 5%	228141
U1	DRIVER, ULN 2004A, SPRAGUE	13046
U2	DRIVER, ULN 2004A, SPRAGUE	13046
U3	QUAD 2-INPUT NAND GATE, MC 14011 BCP, MOTOROLA	13030

PARTS LIST

LOGIC CONTROL P/C BD. ASSEMBLY A1A4 (Part No. A15D005)

(2 of 2)

Reference Designation	Description	MLA Part No.
U4	QUAD 2-INPUT NAND GATE, MC 14011 BCP, MOTOROLA	13030
U5	QUAD 2-INPUT NAND GATE, MC 14011 BCP, MOTOROLA	13030
U6	QUAD 2-INPUT NAND GATE, MC 14011 BCP, MOTOROLA	13030
U7	QUAD 2-INPUT NAND GATE, MC 14011 BCP, MOTOROLA	13030
U8	DUAL D FLIP-FLOP, MC 14013 BCP, MOTOROLA	13031
U9	DUAL D FLIP-FLOP, MC 14013 BCP, MOTOROLA	13031
U10	TRIPLE 3-INPUT NAND GATE, MC 14023 BCP, MOTOROLA	13032
U11	TRIPLE 3-INPUT NAND GATE, MC 14023 BCP, MOTOROLA	13032
U12	TRIPLE 3-INPUT NAND GATE, MC 14023 BCP, MOTOROLA	13032
U13	QUAD 2-INPUT NOR GATE, MC 14001 BCP, MOTOROLA	13033
U14	QUAD 2-INPUT NOR GATE, MC 14001 BCP, MOTOROLA	13033
U15	QUAD 2-INPUT NAND GATE, MC 14011 BCP, MOTOROLA	13030
U16	DUAL D FLIP-FLOP, MC 14013 BCP, MOTOROLA	13031
U17	DIVIDE BY N FOUR BIT COUNTER, MC 14526 BCP, MOTOROLA	13034
U18	QUAD 2-INPUT NAND GATE, MC 14011 BCP, MOTOROLA	13030
U19	HEX INVERTER, MC 14069 BCP, MOTOROLA	13035
U20	HEX INVERTER, MC 14069 BCP, MOTOROLA	13035
U21	SIX DECADE COUNTER/DISPLAY DRIVER MK 50395N, MOSTEK	13036
U22	TIME BASE GENERATOR, MC 14566 BCP, MOTOROLA	13037
U23	DUAL BINARY TO 1 of 4 DECODER, MC 14555 BCP, MOTOROLA	13038
U24	QUAD 2-INPUT NOR GATE, MC 14001 BCP, MOTOROLA	13033

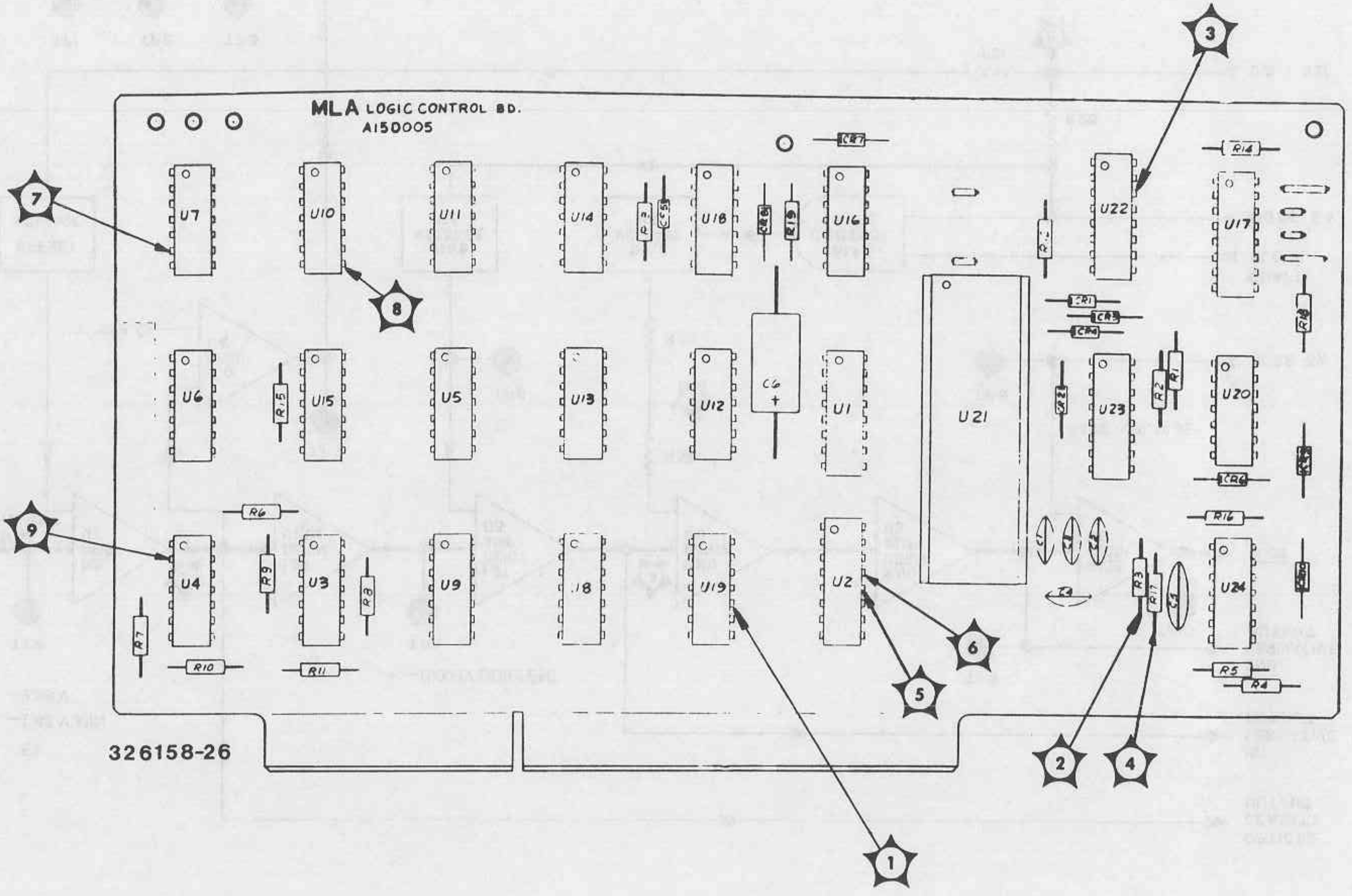
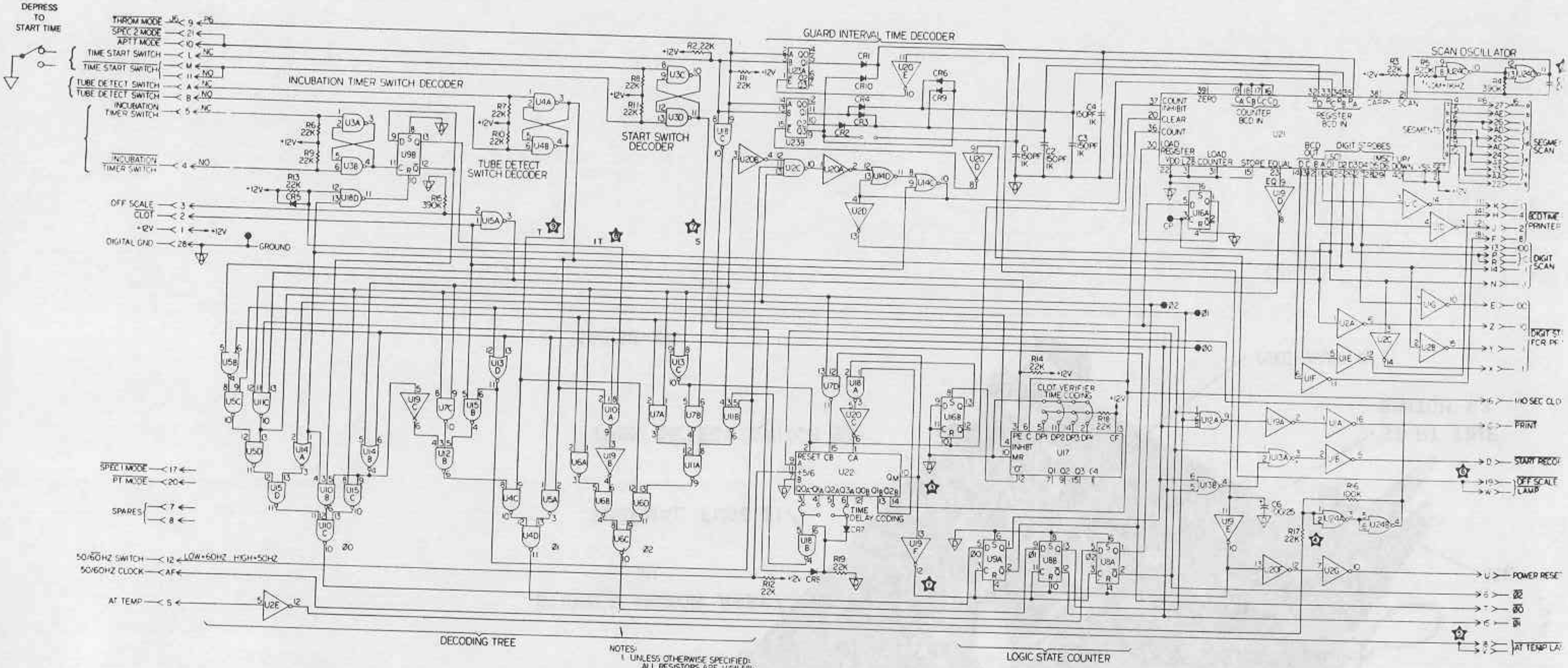

MLA LOGIC CONTROL BD.
A150005
U7
U10
U11
U14
U18
U16
U22
U17
U6
U15
U5
U13
U12
U1
U21
U23
U20
U4
U3
U9
18
U19
U2
U24
C6
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R14
R15
R16
R17
R18
R19
CR1
CR2
CR3
CR4
CR6
CR7
CR8
C1
C2
C3
C4
C5
326158-26
1
2
3
4
5
6
7
8
9

Figure 11-11. Typical Logic Assembly A1A4


DEPRESS TO START TIME
THROM MODE
SPEC 2 MODE
APTT MODE
TIME START SWITCH
TUBE DETECT SWITCH
INCUBATION TIMER SWITCH
INCUBATION TIMER SWITCH DECODER
TUBE DETECT SWITCH DECODER
START SWITCH DECODER
GUARD INTERVAL TIME DECODER
SCAN OSCILLATOR
COUNT INHIBIT
CLEAR
COUNT
LOAD REGISTER
ZERO
COUNTER BCD IN
REGISTER BCD IN
CARRY
SCAN
SEGMENTS
BCD OUT
DIGIT STROBES
LOAD COUNTER
STORE EQUAL
SEGMENT SCAN
BCD TIME
PRINTER
DIGIT SCAN
DIGIT STROBE FOR PRINTER
OFF SCALE
CLOT
+12V
DIGITAL GND
GROUND
SPEC 1 MODE
PT MODE
SPARES
50/60HZ SWITCH
LOW=60HZ HIGH=50HZ
50/60HZ CLOCK
AT TEMP
CLOT VERIFIER TIME CODING
TIME DELAY CODING
RESET
1/10 SEC CLOCK
PRINT
START RECORD
OFF SCALE LAMP
POWER RESET
AT TEMP LAMP
DECODING TREE
LOGIC STATE COUNTER

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE 1/4W, 5%
ALL CAPACITORS ARE EXPRESSED IN MFD
ALL DIODES ARE 1N914
2. ALL 14 PIN IC'S, PIN 7 GROUND, PIN 14 +12V. ALL 16 PIN IC'S, PIN 8 GROUND PIN 16 +12V EXCEPT U1 & U2, PIN 8 GROUND, PIN 9 +12V. ALL OTHER IC'S REFER TO DRAWING

UNUSED GATES

6 U2F 11

3. REFERENCE DESIGNATION PREFIX IS A1A4

Figure 11-12. Logic Schematic Diagram P/N A15D005

PARTS LIST

HEATER BLOCK ASSEMBLY A2 (Part No. A15D300)

(1 of 1)

Reference Designation	Description	MLA Part No.
2A1	PRE-AMP P/C BOARD ASSEMBLY	A15B020
2A2	DISPLAY P/C BOARD ASSEMBLY	A15D001
2S1	SWITCH, ROCKER	10862
DS1	PHOTO LAMP ASSEMBLY	9012
	CAP, PUSHBUTTON SWITCH	10861
	HEATER BLOCK	15R301
	KNOB, MODE SELECTOR	30607
M1	STIRRER MOTOR ASSEMBLY	A15B329
M1	*STIRRER MOTOR ONLY	10131
	0.1 ML PIPETTE	1016
	0.2 ML PIPETTE	1017
	THERMOMETER	15A424
	REAGENT RESERVOIR	620B1-0-24
	REAGENT RESERVOIR COVER	30211
	MAGNETIC STIR BAR	30951
	PLUNGER (START SWITCH)	15A324
F1	THERMAL FUSE	A15A043
R1	THERMISTOR	15B333
R2	HEATER ELEMENT	10504
S2	SWITCH, MICRO, START TIMING	10817
S3	SWITCH, MICRO, TUBE DETECT	10804
	TEST WELL	A15A302

*Per S/N 101-260 Requires Two Wire Terminals 12287 to Crimp to Harness

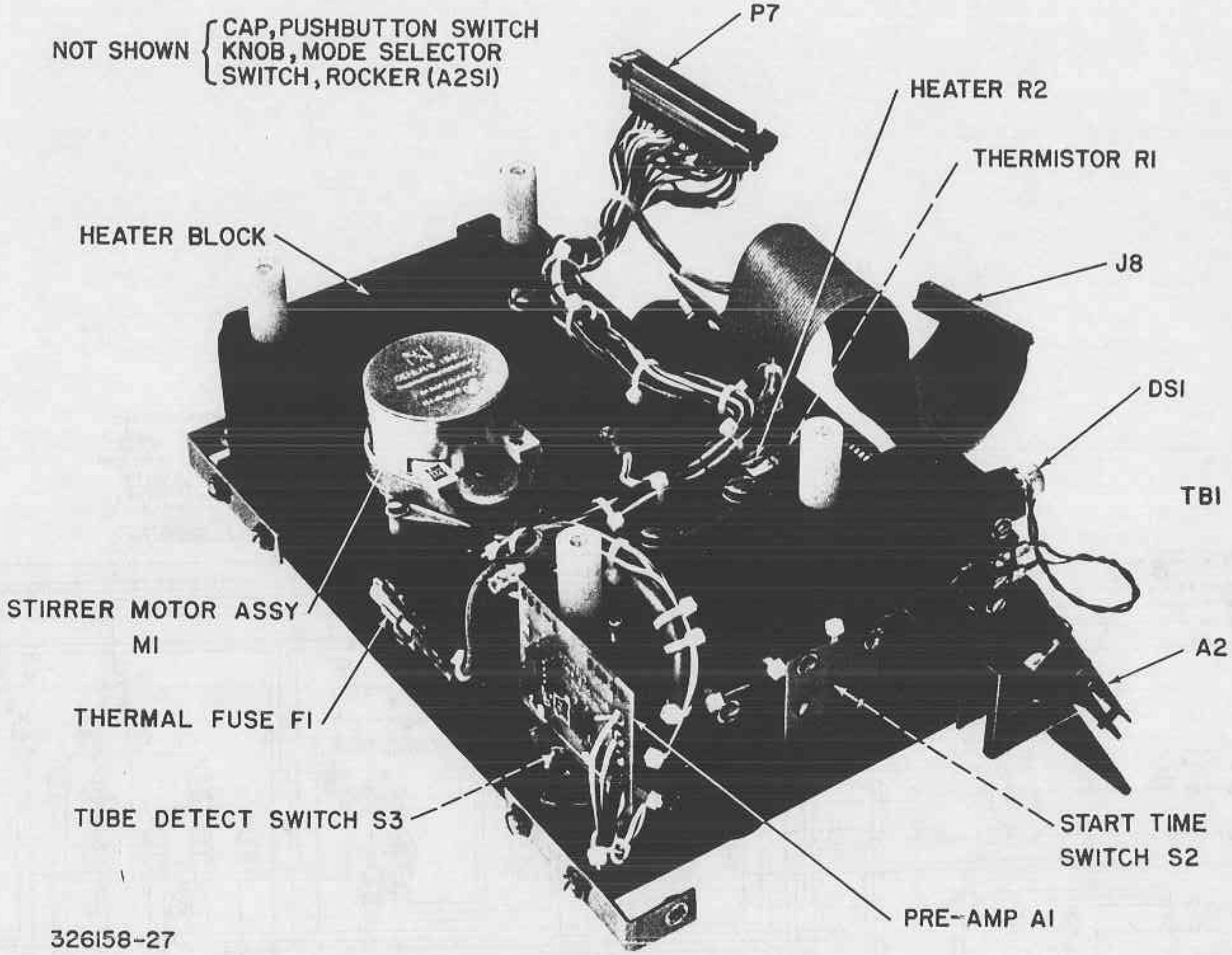

NOT SHOWN
CAP, PUSHBUTTON SWITCH
KNOB, MODE SELECTOR
SWITCH, ROCKER (A2S1)
P7
HEATER R2
THERMISTOR R1
HEATER BLOCK
J8
DS1
TB1
STIRRER MOTOR ASSY
M1
A2
THERMAL FUSE F1
TUBE DETECT SWITCH S3
START TIME
SWITCH S2
PRE-AMP A1
326158-27

Figure 11-13. Heater Assembly A2

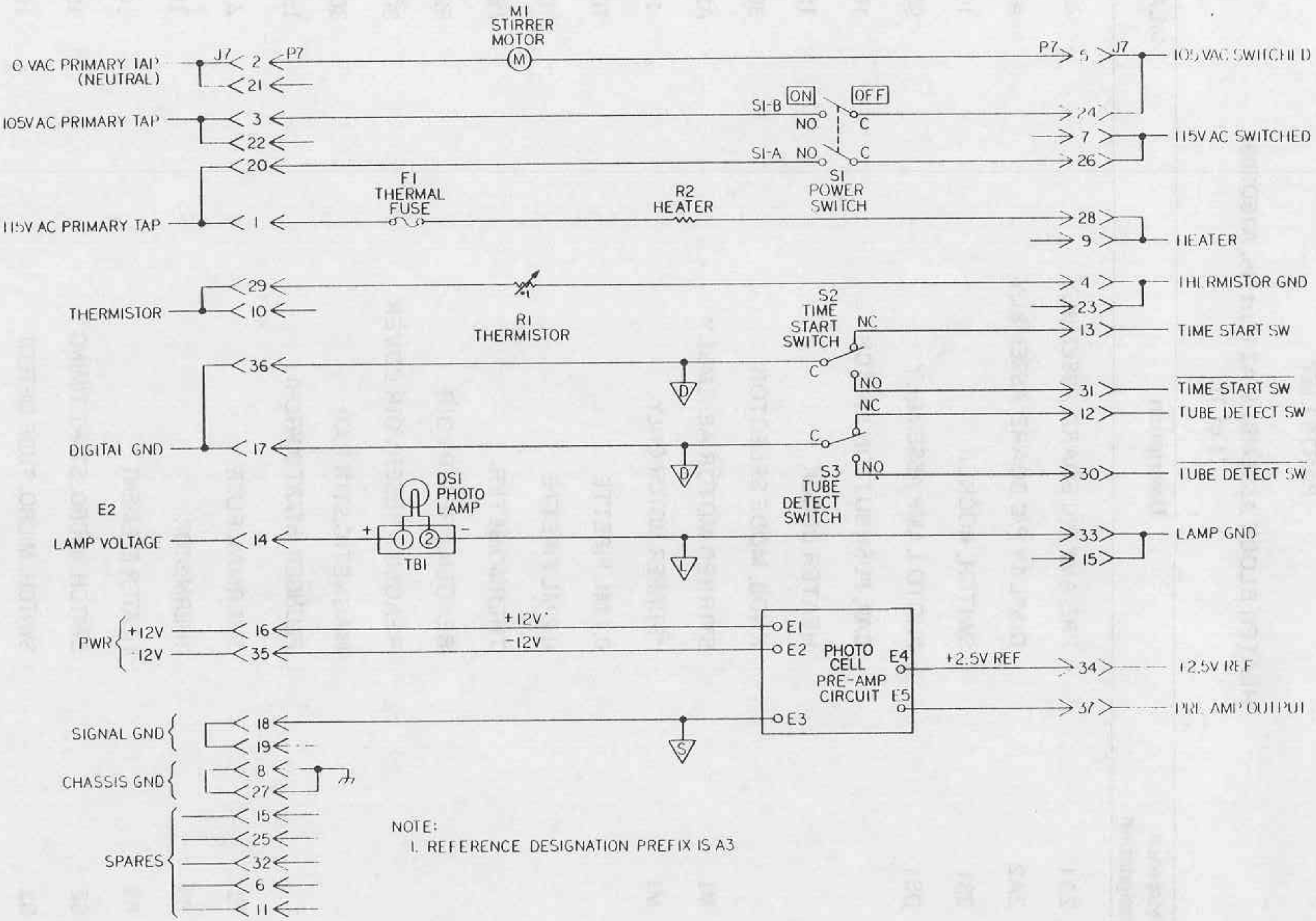

M1
STIRRER
MOTOR
0 VAC PRIMARY TAP
(NEUTRAL)
J7
P7
2
21
105V AC PRIMARY TAP
3
22
20
115V AC PRIMARY TAP
1
F1
THERMAL
FUSE
R2
HEATER
S1-B
ON
OFF
NO
C
S1-A
NO
C
S1
POWER
SWITCH
P7
J7
5
24
7
26
28
9
105 VAC SWITCHED
115V AC SWITCHED
HEATER
THERMISTOR
29
10
R1
THERMISTOR
4
23
THERMISTOR GND
S2
TIME
START
SWITCH
NC
C
NO
13
TIME START SW
31
TIME START SW
DIGITAL GND
36
17
D
D
NC
C
NO
S3
TUBE
DETECT
SWITCH
12
TUBE DETECT SW
30
TUBE DETECT SW
DS1
PHOTO
LAMP
E2
LAMP VOLTAGE
14
+
1
2
-
TB1
L
33
15
LAMP GND
PWR
+12V
-12V
16
35
+12V
-12V
E1
E2
PHOTO
CELL
PRE-AMP
CIRCUIT
E4
E5
E3
+2.5V REF
34
+2.5V REF
37
PRE AMP OUTPUT
SIGNAL GND
18
19
S
CHASSIS GND
8
27
SPARES
15
25
32
6
11
NOTE:
1. REFERENCE DESIGNATION PREFIX IS A3

Figure 11-14. Heater Schematic Diagram

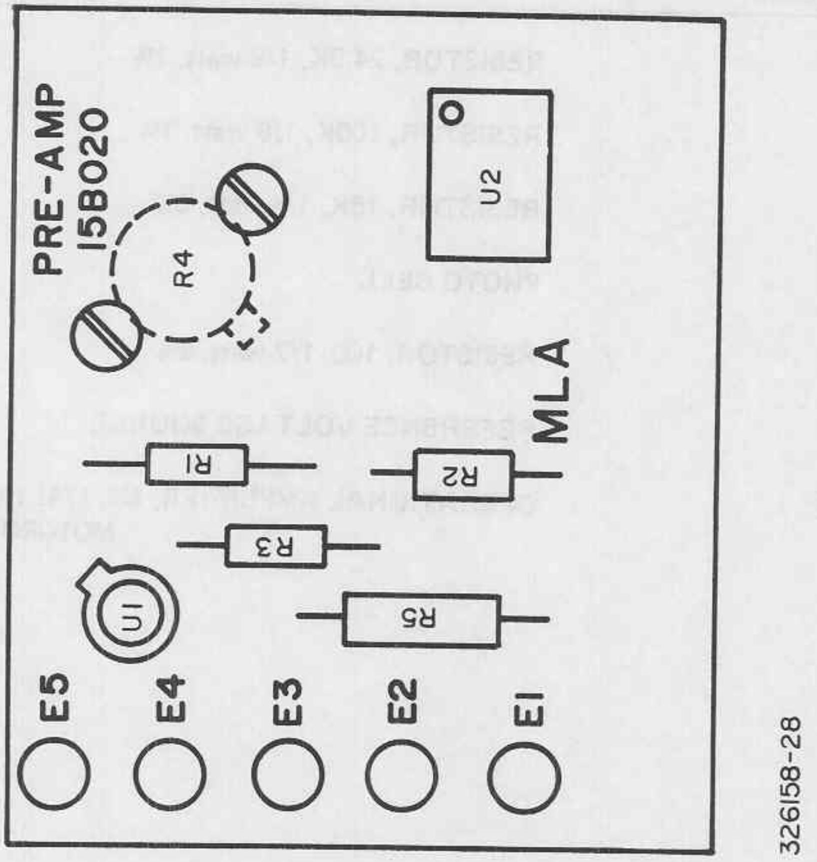

PRE-AMP
15B020
R4
U2
MLA
R1
R2
R3
R5
U1
E5
E4
E3
E2
E1
326158-28

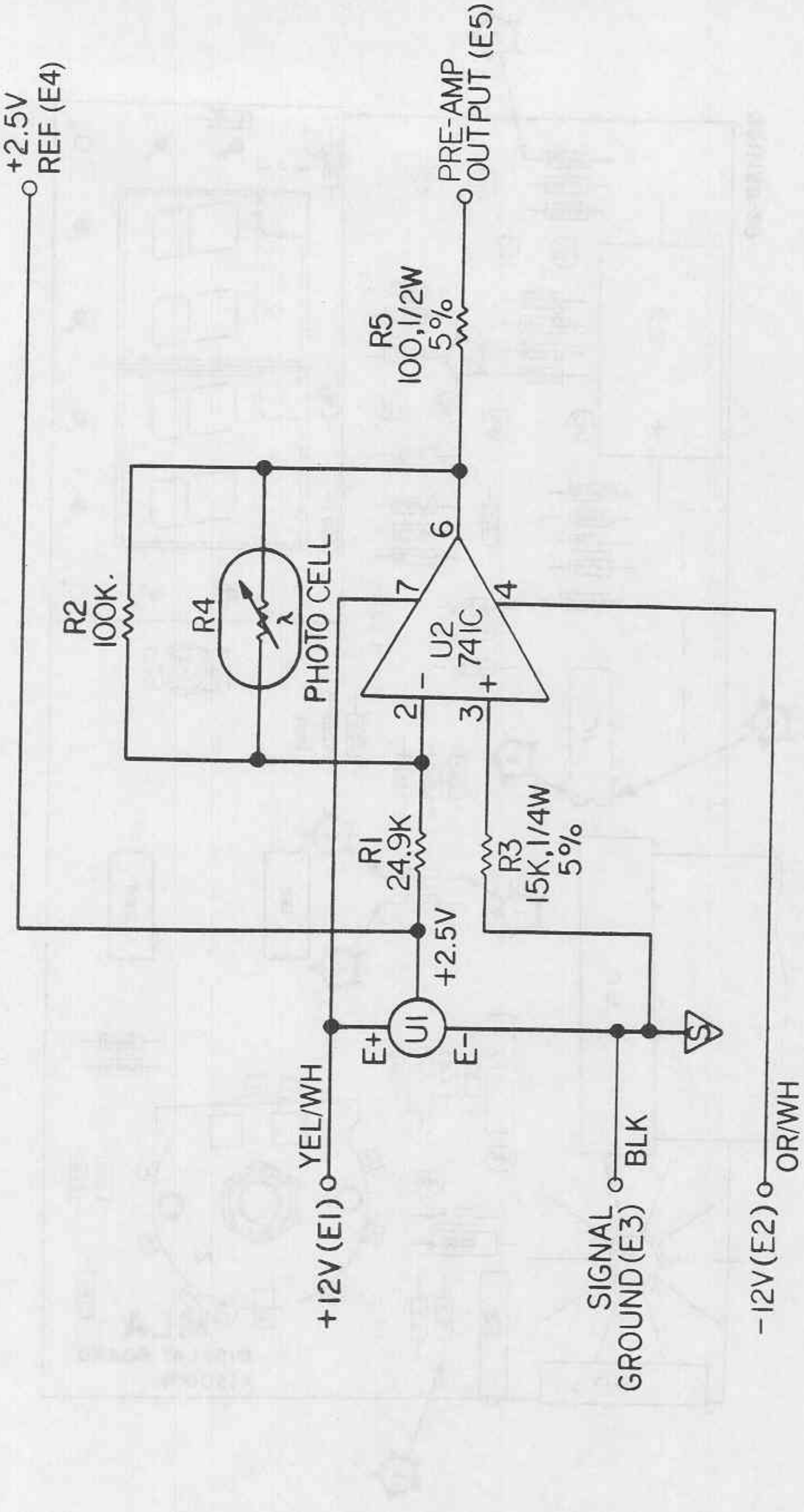
Figure 11-15. Pre-Amp Assembly A2A1

PARTS LIST

PRE-AMPLIFIER P/C BOARD ASSEMBLY A2A1 (Part No. A15B020)

(1 of 1)

Reference Designation	Description	MLA Part No.
R1	RESISTOR, 24.9K, 1/8 watt, 1%	128105
R2	RESISTOR, 100K, 1/8 watt, 1%	12807
R3	RESISTOR, 15K, 1/4 watt, 5%	228139
R4	PHOTO CELL	11549
R5	RESISTOR, 100, 1/2 watt, 5%	22842
U1	REFERENCE VOLTAGE SOURCE	13045
U2	OPERATIONAL AMPLIFIER, MC 1741 NC-PL MOTOROLA	10361


+2.5V
REF (E4)
PRE-AMP
OUTPUT (E5)
R5
100,1/2W
5%
R2
100K.
R4
λ
PHOTO CELL
7
6
4
2
3
U2
741C
-
+
R1
24.9K
R3
15K,1/4W
5%
+2.5V
E+
U1
E-
YEL/WH
+12V(E1)
SIGNAL
GROUND(E3)
BLK
-12V(E2)
OR/WH

NOTES:

1. ALL RESISTORS 1/8W, 1% UNLESS OTHERWISE SPECIFIED.
2. REFERENCE DESIGNATION PREFIX A2A1

Figure 11-16. Pre-Amp Schematic Diagram

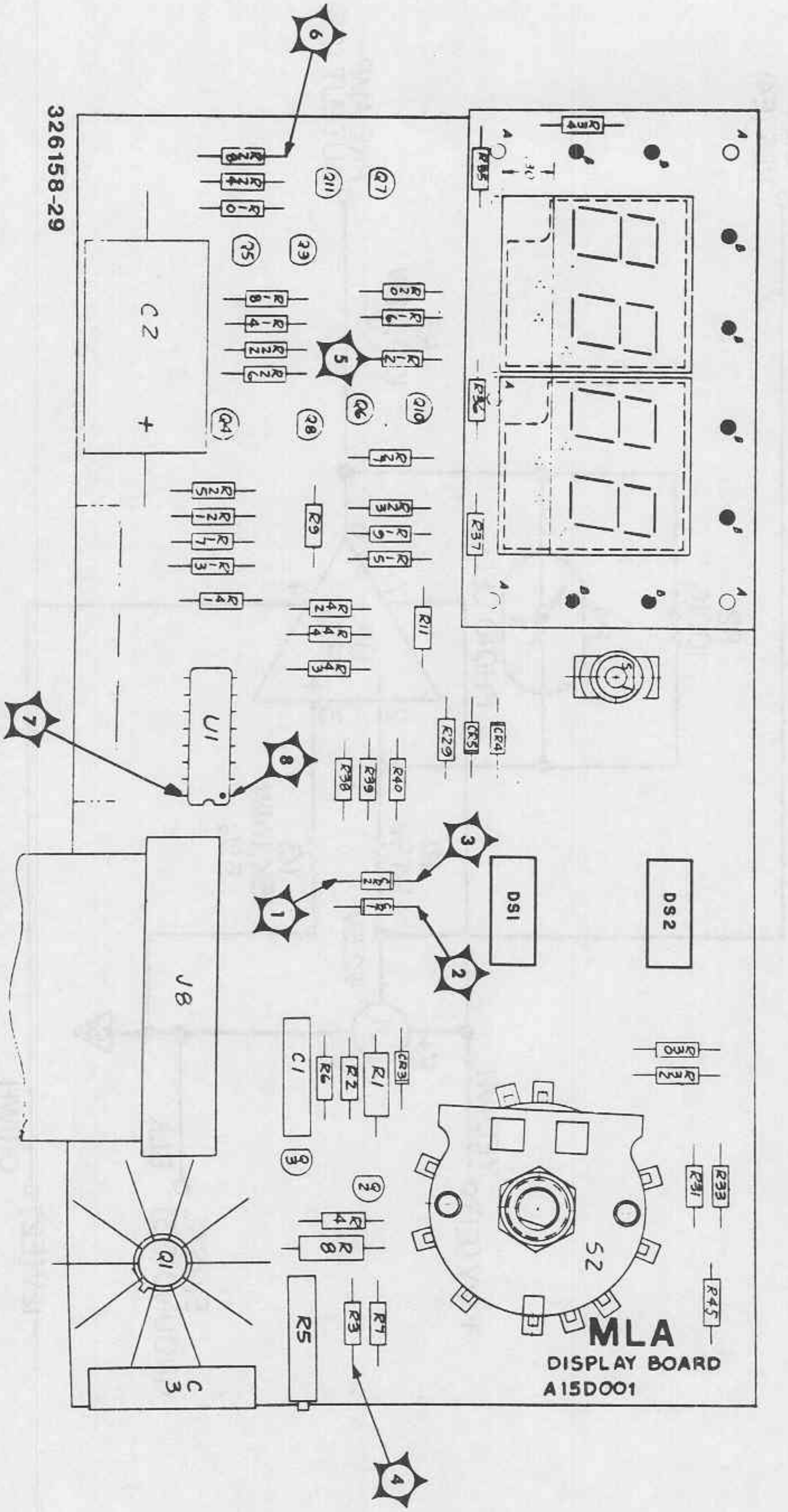

326158-29
MLA
DISPLAY BOARD
A15D001
C2
C1
C3
J8
U1
DS1
DS2
S1
S2
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
R1
R2
R3
R4
R5
R6
R8
R9
R11
R29
R31
R33
R37
R38
R39
R40
R45
CR3
CR4
CR5
1
2
3
4
5
6
7
8

Figure 11-17. Display Assembly A2A2

PARTS LIST

DISPLAY BOARD ASSEMBLY A2A2 (Part No. 70141)

(1 of 2)

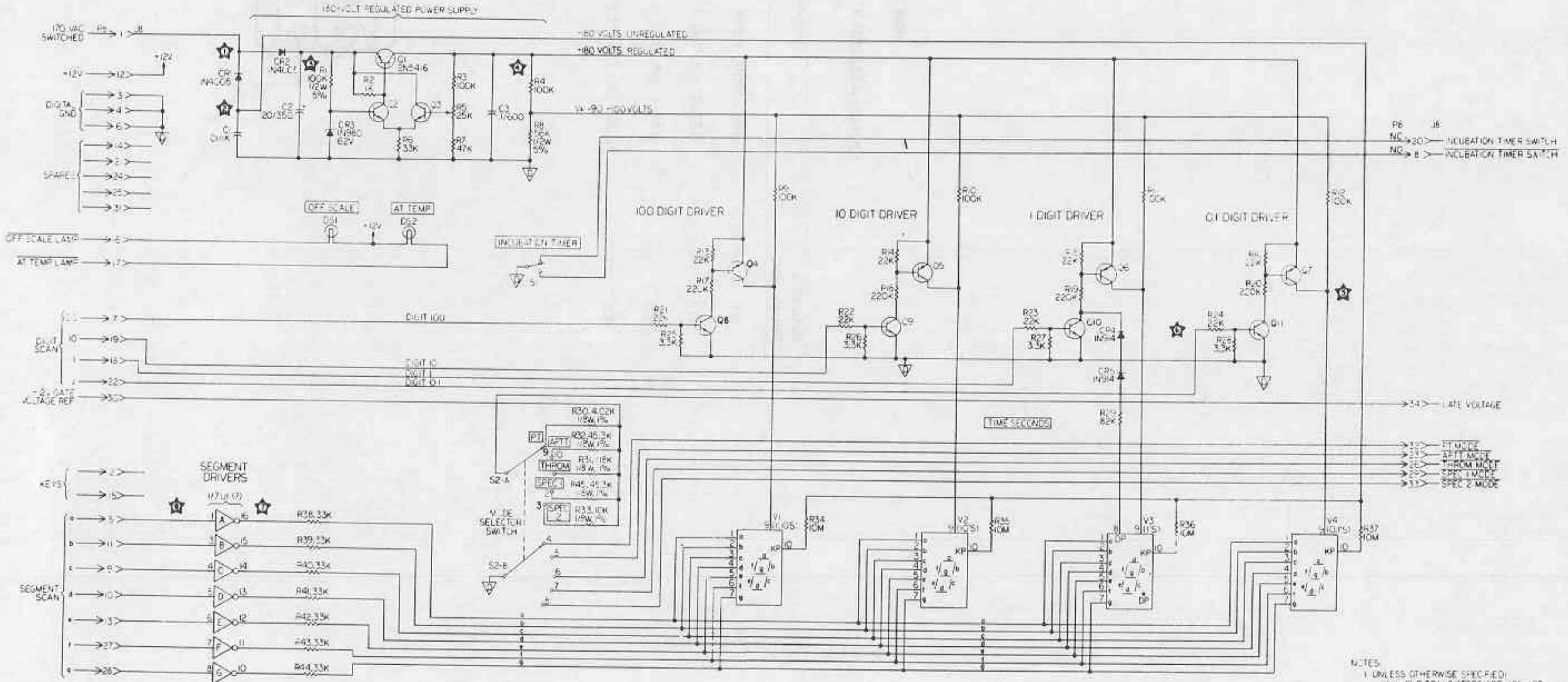
Reference Designation	Description	MLA Part No.
C1	CAPACITOR, 0.01/1KV, 20%, CERAMIC	12584
C2	CAPACITOR, 20/350, ELECTROLYTIC	12509
C3	CAPACITOR, 0.1/600, CERAMIC	12585
CR1	DIODE, 1N4005	12620
CR2	DIODE, 1N4005	12620
CR3	DIODE, 1N980	12611
CR4	DIODE, 1N914	12610
CR5	DIODE, 1N914	12610
Q1	TRANSISTOR, 2N5416	11626
Q2	TRANSISTOR, MPS–A42, MOTOROLA	11629
Q3	TRANSISTOR, MPS–A42, MOTOROLA	11629
Q4	TRANSISTOR, MPS–A92, MOTOROLA	11627
Q5	TRANSISTOR, MPS–A92, MOTOROLA	11627
Q6	TRANSISTOR, MPS–A92, MOTOROLA	11627
Q7	TRANSISTOR, MPS–A92, MOTOROLA	11627
Q8	TRANSISTOR, MPS–A42, MOTOROLA	11629
Q9	TRANSISTOR, MPS–A42, MOTOROLA	11629
Q10	TRANSISTOR, MPS–A42, MOTOROLA	11629
Q11	TRANSISTOR, MPS–A42, MOTOROLA	11629
R1	RESISTOR, 100K, 1/2 watt, 5%	22806
R2	RESISTOR, 1K, 1/4 watt, 5%	228125
R3	RESISTOR, 100K, 1/4 watt, 5%	228149
R4	RESISTOR, 100K, 1/4 watt, 5%	228149
R5	RESISTOR, POT. 25K	12729
R6	RESISTOR, 33K, 1/4 watt, 5%	228143
R7	RESISTOR, 47K, 1/4 watt, 5%	228145
R8	RESISTOR, 56K, 1/2 watt, 5%	22848
R9	RESISTOR, 100K, 1/4 watt, 5%	228149
R10	RESISTOR, 100K, 1/4 watt, 5%	228149
R11	RESISTOR, 100K, 1/4 watt, 5%	228149
R12	RESISTOR, 100K, 1/4 watt, 5%	228149
R13	RESISTOR, 22K, 1/4 watt, 5%	228141
R14	RESISTOR, 22K, 1/4 watt, 5%	228141
R15	RESISTOR, 22K, 1/4 watt, 5%	228141
R16	RESISTOR, 22K, 1/4 watt, 5%	228141
R17	RESISTOR, 220K, 1/4 watt, 5%	228153
R18	RESISTOR, 220K, 1/4 watt, 5%	228153
R19	RESISTOR, 220K, 1/4 watt, 5%	228153
R20	RESISTOR, 220K, 1/4 watt, 5%	228153

PARTS LIST

DISPLAY BOARD ASSEMBLY A2A2(Part No. A15D001)

(2 of 2)

Reference Designation	Description	MLA Part No.
R21	RESISTOR, 22K, 1/4 watt, 5%	228141
R22	RESISTOR, 22K, 1/4 watt, 5%	228141
R23	RESISTOR, 22K, 1/4 watt, 5%	228141
R24	RESISTOR, 22K, 1/4 watt, 5%	228141
R25	RESISTOR, 3.3K, 1/4 watt, 5%	228131
R26	RESISTOR, 3.3K, 1/4 watt, 5%	228131
R27	RESISTOR, 3.3K, 1/4 watt, 5%	228131
R28	RESISTOR, 3.3K, 1/4 watt, 5%	228131
R29	RESISTOR, 82K, 1/4 watt, 5%	228148
R30	RESISTOR, 4.02K, 1/8 watt, 1%	128115
R31	RESISTOR, 118K, 1/8 watt, 1%	128117
R32	RESISTOR, 45.3K, 1/8 watt, 1%	128116
R33	RESISTOR, 10K, 1/8 watt, 1%	128104
R34	RESISTOR, 10M, 1/4 watt, 5%	228173
R35	RESISTOR, 10M, 1/4 watt, 5%	228173
R36	RESISTOR, 10M, 1/4 watt, 5%	228173
R37	RESISTOR, 10M, 1/4 watt, 5%	228173
R38	RESISTOR, 33K, 1/4 watt, 5%	228143
R39	RESISTOR, 33K, 1/4 watt, 5%	228143
R40	RESISTOR, 33K, 1/4 watt, 5%	228143
R41	RESISTOR, 33K, 1/4 watt, 5%	228143
R42	RESISTOR, 33K, 1/4 watt, 5%	228143
R43	RESISTOR, 33K, 1/4 watt, 5%	228143
R44	RESISTOR, 33K, 1/4 watt, 5%	228143
R45	RESISTOR, 45.3K, 1/8 watt, 1%	128116
S1	SWITCH, SPDT– MOMENTRY SWITCH	10860
S2	SWITCH, 2 - POLE 5 - POS ROTARY	10819
U1	HIGH VOLTAGE DRIVER UHP – 481, SPRAGUE	13048
V1,V2,V3,V4	DISPLAY	11511
DS1, DS2	LAMP, PEAK "AT TEMP"/"OFF SCALE"	11908


180-VOLT REGULATED POWER SUPPLY
170 VAC SWITCHED
P6
J6
+12V
DIGITAL GND
SPARES
+180 VOLTS UNREGULATED
+180 VOLTS REGULATED
V+ -90 +100 VOLTS
CR1 IN4005
CR2 IN4005
C1 0.01K
C2 20/350
R1 100K 1/2W 5%
CR3 IN960 6.2V
Q1 2N5416
R2 1K
Q2
Q3
R3 100K
R5 25K
R7 47K
R6 33K
C3 1/600
R4 100K
R8 56K 1/2W 5%
OFF SCALE
AT TEMP
DS1
DS2
OFF SCALE LAMP
AT TEMP LAMP
INCUBATION TIMER
S
100 DIGIT DRIVER
10 DIGIT DRIVER
1 DIGIT DRIVER
0.1 DIGIT DRIVER
DIGIT SCAN
DIGIT 100
DIGIT 10
DIGIT 1
DIGIT 0.1
+2V GATE VOLTAGE REF
KEYS
SEGMENT DRIVERS
U7
SEGMENT SCAN
MODE SELECTOR SWITCH
S2-A
S2-B
PT
APTT
THROM
SPEC 1
SPEC 2
R30 4.02K 1/8W 1%
R32 46.3K 1/8W 1%
R31 18K 1/8W 1%
R45 45.3K 1/8W 1%
R33 10K 1/8W 1%
TIME SECONDS
V1
V2
V3
V4
KP
DP
R34 10M
R35 10M
R36 10M
R37 10M
INCUBATION TIMER SWITCH
INCUBATION TIMER SWITCH
GATE VOLTAGE
PT MODE
APTT MODE
THROM MODE
SPEC 1 MODE
SPEC 2 MODE

NOTES
1. UNLESS OTHERWISE SPECIFIED:
ALL PNP TRANSISTORS ARE MPS-A92
ALL NPN TRANSISTORS ARE MPS-A42
ALL RESISTORS ARE 1/4W,5%
ALL CAPACITORS ARE EXPRESSED IN MFD
2. REFERENCE DESIGNATION PREFIX IS A3

Figure 11-18. Display Schematic Diagram

PARTS LIST

SWITCH ASSEMBLY A3 (Part No. A15A048)

(1 of 1)

Reference Designation	Description	MLA Part No.
R1	RESISTOR, 1.24K, 1/8 watt, 1%	12827
R2	RESISTOR, 750, 1/8 watt, 1%	12826
R3	RESISTOR, 750, 1/8 watt, 1%	12826
S3	SWITCH, TOGGLE	10833

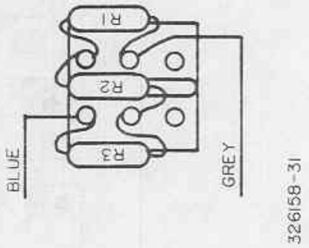


Figure 11-19. Switch Assembly Parts Location

SECTION 12

WARRANTY AND REPAIR POLICY

12.1 INTRODUCTION

An instrument warranty statement is included in this section together with a parts replacement policy, a return goods policy and procedure, and an ordering procedure. Terms in this section are defined at the end of this section.

12.2 WARRANTY

The Electra 750 is warranteed to be free, under normal use and authorized service, from defects in workmanship and material for a period of one year from the date of installation. The Photolamp, MLA Catalog #9012, is guaranteed for a period of 30 days. THIS EXPRESS WARRANTY IS IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND IN LIEU OF ANY OTHER OBLIGATION ON THE PART OF MLA.

Such express warranty shall not be effective unless this instrument is serviced soley by service agents authorized by MLA. MLA shall not be liable for any damage to or defect in the instrument or for any personal injury or property damage which may be caused by the instrument subsequent to any servicing by unauthorized personnel.

This warranty shall be fulfilled by MLA's authorized dealers. Contact your authorized MLA distributor of service dealer when help is needed. MLA's Technical Service Department is available by phone to both customer and dealer when required.

MLA's LIABILITY FOR DAMAGES SHALL NOT EXCEED THE AMOUNT RECEIVED BY IT FOR THIS INSTRUMENT. IN NO EVENT SHALL MLA BE LIABLE FOR INCIDENTAL CONSEQUENTIAL OR SPECIAL DAMAGES, RELATING EITHER TO PERSONAL INJURY OR TO PROPERTY DAMAGE.

For prompt consideration of claims, the Warranty Card, properly executed, must be returned to MLA.

12.3 REPLACEMENT PART POLICY

12.3.1 A replacement part furnished by MLA, has either a 90-day warranty following its installation in a specific instrument; or the duration of the instrument warranty whichever is longer. The warranty card included with the parts shipment must be completed and returned to MLA at the time of installation to secure this warranty.

12.3.2 When parts are supplied from agent's stock, the warranty extended by the agent to the customer will be supported by MLA, but will not exceed the terms of 12.3.1 above, provided the part has not exceeded a shelf life of three (3) years.

12.3.3 Replacement parts are repaired parts that have been tested to new part standards.

12.4 RETURN GOODS POLICY

All parts returned to MLA must be approved for return, by the Technical Services Department (T/S) of MLA. When parts are to be returned, contact MLA T/S with the following information:

1. Your Name
2. Your Agent's Name
3. Customer Name & Location
4. Instrument Type & Serial Number
5. Part Number and Serial Number of Part
6. Defect in part
7. Warranty claim

Upon receipt of this information, a return authorization number will be issued, which must accompany the part to be returned. MLA reserves the right to return shipments of return parts without this number on the outside of the carton.

Parts that are returned will be examined for damage during shipment and further inspected to determine cause of failure. When the item is determined to be an obsolete revision level, no credit will be allowed.

Parts accepted will have credit issued based on repairability. When returned parts do not meet repairability standard, no credit will be issued and the sender notified of such a decision.

Parts returned should be done so in their original packaging or good shipping practice should be exercised. Instruments that are returned must be returned in their original packing material. To ship otherwise, may jeopardize the warranty and/or cause damage to the instrument.

12.5 ORDERING POLICY AND PROCEDURE

MLA does not normally accept direct orders from customers. However, when an order is placed regardless of its origin, the following information must be provided:

1. User's name and address (Agent, when for agent's stock)
2. Instrument type and serial number
3. Final use (stock or immediate installation)
4. Part number
5. Replacement or Brand New part
6. Type of shipment desired
7. Return of defective part anticipated

Price list for parts is a separate sheet, which is dated.

12.6 DEFINITION OF TERMS

Terms used in this section are defined below.

NEW PART – A part that has never been used in an instrument for other than testing.

OBSOLETE PART – A part that is no longer used in the original application and is usually stocked by MLA is very small quantities or not all, depending on whether a replacement has been provided.

RETURN AUTHORIZATION NUMBER – A number assigned by the MLA Technical Services Department to parts or instruments being returned to MLA. The issuance of this number provides authorization to return items to MLA.

REPLACEMENT PART – A replacement part is a part that has passed through MLA's Quality Control function to assure that the performance is that of a new part. This part, however, is not necessarily a new part.

RETURNED PART – Any part that has been returned to MLA for any reason. Each such part must have an authorization number to be accepted at MLA. It is assumed that the part is repairable, unless it is returned for investigation reasons.

REVISION LEVEL – Determines level of design or modification. Changes to parts are made on the basis of revision levels. To replace a part, the revision level must be known. This knowledge permits replacement by either the same or a higher level revision.

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SECTION 2 TABLE OF SPECIFICATIONS

- On page 2-2, change AT TEMP Indicator to read:
  Lights when within ±1 °C of factory set temperature
  Range 25 to 45 °C
  Accuracy ±0.5 °C from 30 °C to 40 °C

- Add Operating Temperature Range:
  10 °C to 32 °C, or 50 °F to 88 °F

- Add Relative Humidity Operating Range:
  0 to 60% Noncondensing

- Add Indoor Storage Temperature Limitations:
  -40 °C to +55 °C

- Add Indoor Storage Humidity Limitations:
  0 to 90% Noncondensing

- Add: The ELECTRA 750 and 750A Coag Instruments are designed for indoor office laboratory conditions only. These instruments are not to be stored outdoors.

SECTION 3 UNPACKING AND REPACKING

- On page 3-1, paragraph 3.2, change the reorder number of the 0.1-mL Precision "D" Pipette to read "1055C".

- On page 3-1, paragraph 3.2, change the reorder number of the Dust Cover to read "15A436".

SECTION 4 INSTALLATION

- On page 4-3, replace the INITIAL TESTING (OPERATOR CONFIDENCE TEST) with the following:

4.3.1 Timer Check

a) Set the display panel "ON/OFF" switch to the "ON" position. The "TIME" display should read ".0" and when the heating block is up to temperature the "AT TEMP" light should illuminate.

b) Press the "INCUBATION TIMER" button to initiate display timing. Press the "INCUBATION TIMER" button a second time to stop the display timing and reset the display to ".0".

c) Using a precision stopwatch, start the Incubation Timer and stopwatch simultaneously. Stop the stopwatch when the display reaches "60.0" seconds. Both the watch and the display should agree within the limits of your response time. Repeat as necessary.

d) Press the "INCUBATION TIMER" button to reset Display Time to ".0".

4.3.2 Logic Check

a) Press the "INCUBATION TIMER" button to initiate display timing. Place empty test cuvette into the Test Well. The Display Timer should reset to ".0".

b) Place an instrument pipette over the test cuvette in the Test Well. Select the "THROMBIN" Test Mode. Press the pipette to initiate a clot timing sequence.

Note: If the "OFF SCALE" light goes on, change the "ABC" lamp level switch to a different position (brighter or darker intensity) and repeat step 4.3.2a until the display exceeds "2.0" seconds without an "OFF SCALE" indication.

c) While the ELECTRA 750 continues to time from step 4.3.2b move the "ABC" lamp level switch to the "C" position (darker). The display should stop and hold the time of action.

d) Remove the pipette and cuvette from the Test Well. The display should retain the count obtained in step 4.3.2c.

e) Insert the empty test cuvette into the Test Well. The display should reset to ".0".

4.3.3 Optical Noise Check

a) Insert an empty test cuvette into the Test Well, select the lamp level used in step 4.3.2b, and select the "THROMBIN" Test Mode.

b) Position an instrument pipette over the cuvette in the Test Well, and press the pipette to initiate a clot observation test.

c) Observe the Display Timer. It should continue to time indefinitely. If timing stops before "100.0" seconds, repeat this test to determine the persistence of stopping. If this situation arises, service will be needed to repair cause.

4.3.4 Guard Interval Timer Check

a) Compress a facial tissue into the lower 1/2" of an empty test cuvette to make it opaque (Dark Cuvette).

b) Insert the Dark Cuvette into the Test Well and place an instrument pipette over it.

c) Select the "PT" Test Mode and press the pipette to start a clot observation test. At the end of the "Guard Interval" (see Guard Interval Time Table) the timer should reset to ".0" and the "OFF SCALE" lamp should light. Remove cuvette.

d) Repeat steps 4.3.4b and 4.3.4c for remaining Test Modes.

Table 4-1 Guard Interval Time

Test Mode	Guard Interval Time (Seconds)
PT	7.0
APTT	16.0
Thrombin	2.0
Spec I	7.0 (2.0 for ELECTRA 750A)
Spec II	16.0

- Add paragraph 4.4, Long Term Storage Inspection Instructions.

a) Unpack and install instrument as outlined in Section 3, page 3-1, and Section 4, page 4-1.

b) Perform the Operator Confidence Test as outlined in Section 4 of ELECTRA 750 Service Manual Addendum.

c) Check the continuity of the instrument thermal fuse, MLA part number A15A043. Refer to Section 11, pages 11-22 and 11-23 for thermal fuse location. Note here that the reference designation for the MLA thermal fuse is F1.

d) Repack instrument as outlined in Section 3, page 3-1 of the ELECTRA 750 Service Manual.

SECTION 7 TROUBLESHOOTING

- On page 7-40, there should be a "V" next to the arrow which points downward (located in the waveform column of row TP3). There also should be a "-12V" between the zero line and the plain line of this same location.

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SECTION 8 COAGULATION TESTING

- On page 8-3, under the heading of "Material Required," the part number for the 0.1-mL pipette should read "MLA #1055C."

- On page 8-4, under the heading of "Material Required," the part number for the 0.1-mL pipette should read "MLA #1055C."

- On page 8-6, under the heading of "Material Required," the part number for the 0.1-mL pipette should read "MLA #1055C."

- On page 8-7, under the heading of "Material Required," the part number for the 0.1-mL pipette should read "MLA #1055C."

- On page 8-9, under the heading of "Material Required," the part number for the 0.1-mL pipette should read "MLA #1055C."

- On page 8-14, under the heading of "Material Required," the part number for the 0.1-mL pipette should read "MLA #1055C."

- On page 8-17, under the heading of "Material Required," the part number for the 0.1-mL pipette should read "MLA #1055C."

SECTION 10 ADJUSTMENTS

- On page 10-1, paragraph 10.3, the Test Equipment paragraph should read:
"In order to make measurements or adjustments on the ELECTRA 750 instrument, a Digital Voltmeter and or Oscilloscope capable of measuring as high as 180 volts and ±12 Volts to within an accuracy of ±0.1 Volt must be available. In order to make heater block temperature measurements or adjustments, a thermometecr capable of measuring heater block temperature of 37.2 °C ±0.1 °C must be used."

- On page 10-3, paragraph 10.5.2, step "a" should read as follows:
a) Connect D.C. voltmeter positive and negative leads to test points TP1 and TP3, respectively, on the Amplifier PCB A1A3.

- On page 10-3, paragraph 10.5.3, step "b" should read as follows:
b) Adjust potentiometer R25 on power supply assembly A1A1 to + 2.75 volts ± 0.05 VDC. Remove alligator clip lead from lamp level switch.

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SECTION 11 SCHEMATIC & PARTS LOCATION DIAGRAMS WITH PARTS LIST

- On page 11-3, change the MLA part number of Assembly A2, (ELECTRA 750A) Heater Block, to read "A23D300".

- On page 11-3, change the F1 descriptions to read:
Fuse 2A, 3AG (90 Volt to 125 Volt instruments)
Fuse 1A, 3AG (210 Volt to 250 Volt instruments)

- On page 11-3, change the MLA part number of Switch S4, Slide Switch DPDT, to read "20C286" only. Delete part number "10863," which is also shown.

- On page 11-5, change the figure number at the bottom of the page to read "Figure 11-4 Typical Mother Board Assembly, A1 and Schematic Diagram."

- On page 11-8, change the MLA part number of Transformer T1 to read "15B044."

- On page 11-10, change the MLA part number shown on the AC Power Heater Board component layout drawing to read "A15D014."

- On page 11-13, locate R5 on the schematic diagram for the AC Power Heater Board, and change the resistance value to read "2K to 5K".

- On page 11-23, change the MLA part number of Assembly 2A2, Display Printed Circuit Board, to read "A15D055."

- On page 11-23, delete the second line item for the M1 stirrer motor MLA part number 10131 and the asterisk note at the bottom of the page. This part is no longer available.

- On page 11-23, change the MLA part number of the Reagent Reservoir to read "9004."

- On page 11-23, change the MLA part number of the Reagent Reservoir Cover to read "9008."

- On page 11-23, change the MLA part number of the Magnetic Stir Bar to read "9006."

- On page 11-28, replace the component layout drawing of the Display PCB (Figure 11-17) with the supplied updated drawing MLA part number A15D055.

- On page 11-29, replace the parts list of the Display PCB with the supplied updated MLA parts list part number A15D055. Change the MLA part number at the top of the page to read "A15D055."

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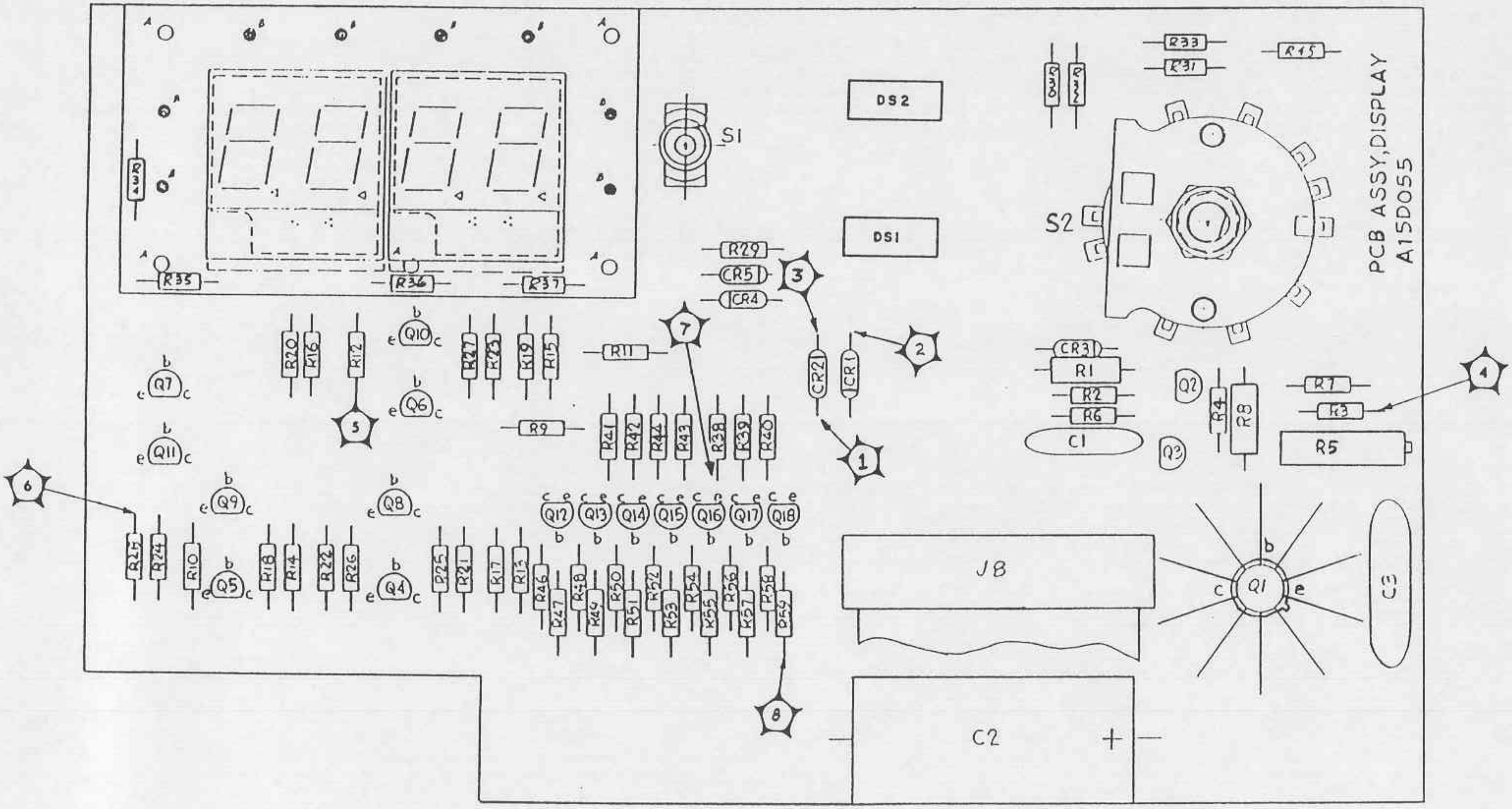
- On page 11-30, replace the parts list of the Display PCB with the supplied updated MLA parts list part number A15D055. Change the MLA part number at the top of the page to read "A15D055."

- On page 11-31, replace the schematic diagram of the Display PCB with the supplied updated MLA schematic diagram part number "S15R057."


PCB ASSY,DISPLAY
A15D055
DS2
DS1
S1
S2
J8
C1
C2
C3
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q15
Q16
Q17
Q18
CR1
CR2
CR3
CR4
CR5
R1
R2
R3
R4
R5
R6
R7
R8
R9
R11
R29
R31
R33
R35
R36
R37
b
c
e
+
1
2
3
4
5
6
7
8

DISPLAY ASSEMBLY A2A2 MLA P/N A15D055

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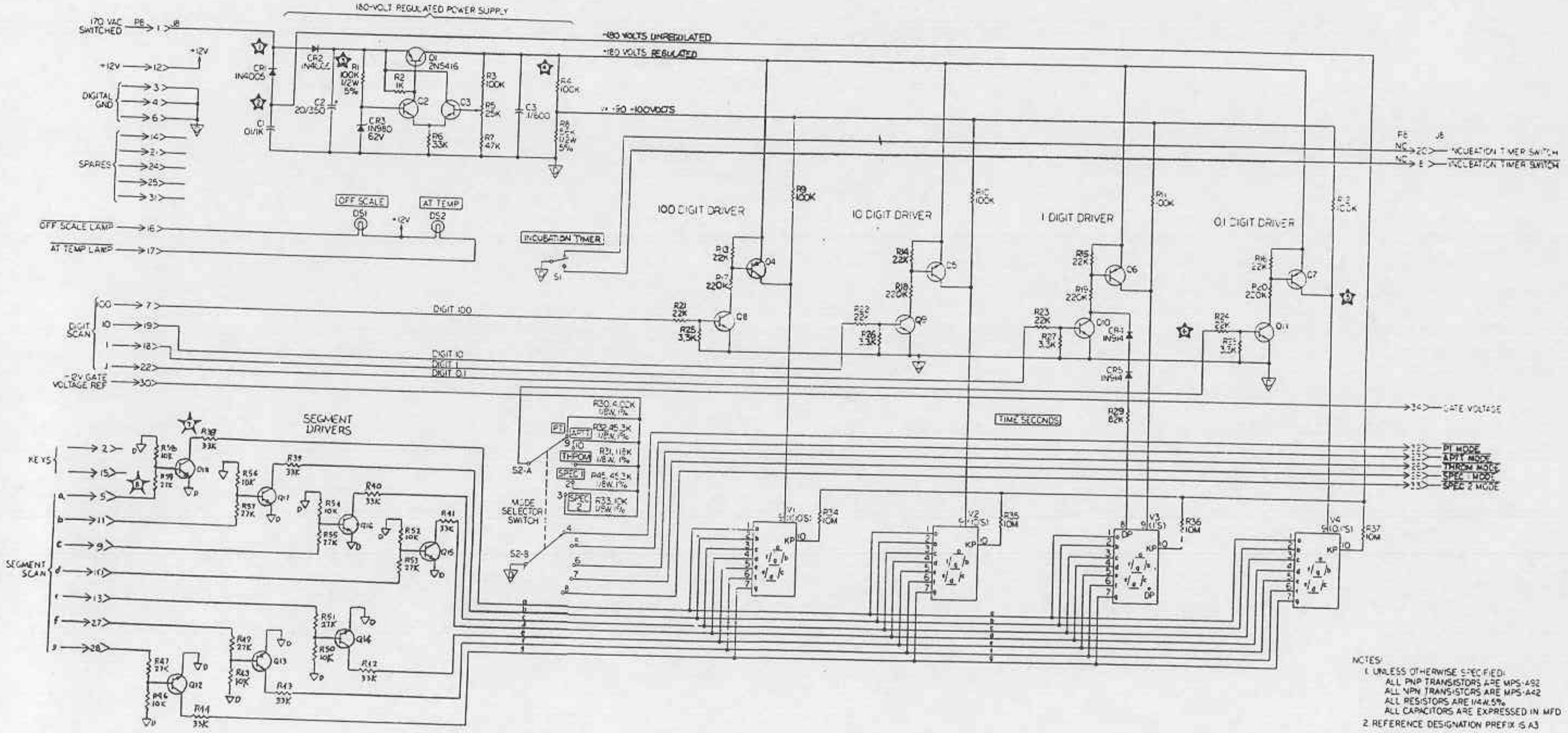
180-VOLT REGULATED POWER SUPPLY
170 VAC SWITCHED
P6
J6
+12V
+180 VOLTS UNREGULATED
+180 VOLTS REGULATED
V+ 90 -100VOLTS
CR1 1N4005
CR2 1N4002
R1 100K 1/2W 5%
Q1 2N5416
R2 1K
C2 20/350
C1 01/1K
CR3 1N980 62V
Q2
Q3
R3 100K
R5 25K
R6 33K
R7 47K
C3 1/600
R4 10CK
R8
DIGITAL GND
SPARES
OFF SCALE
AT TEMP
DS1
DS2
OFF SCALE LAMP
AT TEMP LAMP
INCUBATION TIMER
S1
100 DIGIT DRIVER
10 DIGIT DRIVER
1 DIGIT DRIVER
0.1 DIGIT DRIVER
R9 100K
R10 100K
R11 100K
R12 100K
R13 22K
R14 22K
R15 22K
R16 22K
R17 220K
R18 220K
R19 220K
R20 220K
R21 22K
R22 22K
R23 22K
R24 22K
R25 3.3K
R26 3.3K
R27 3.3K
R28 3.3K
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
CR4 1N914
CR5 1N914
DIGIT SCAN
DIGIT 100
DIGIT 10
DIGIT 1
DIGIT 0.1
-12V GATE VOLTAGE REF
GATE VOLTAGE
TIME SECONDS
R29 82K
SEGMENT DRIVERS
KEYS
SEGMENT SCAN
MODE SELECTOR SWITCH
S2-A
S2-B
PT
APTT
THROM
SPEC 1
SPEC 2
R30 4.02K 1/8W 1%
R32 45.3K 1/8W 1%
R31 118K 1/8W 1%
R45 45.3K 1/8W 1%
R33 10K 1/8W 1%
V1 100S
V2 10S
V3 1S
V4 0.1S
R34 10M
R35 10M
R36 10M
R37 10M
KP
DP
INCUBATION TIMER SWITCH
PT MODE
APTT MODE
THROM MODE
SPEC 1 MODE
SPEC 2 MODE
R18 33K
R19 27K
R39 33K
R40 33K
R41 33K
R42 33K
R43 33K
R44 33K
R56 10K
R57 27K
R54 10K
R55 27K
R52 10K
R53 27K
R51 27K
R50 10K
R47 27K
R46 10K
R43 10K
Q12
Q13
Q14
Q15
Q16
Q17
Q18

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL PNP TRANSISTORS ARE MPS-A92
ALL NPN TRANSISTORS ARE MPS-A42
ALL RESISTORS ARE 1/4W, 5%
ALL CAPACITORS ARE EXPRESSED IN MFD
2. REFERENCE DESIGNATION PREFIX IS A3

Display Schematic Diagram

MLA P/N S15R057